

ASIATIC CHOLERA

By JOHN A. BENSON.

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Asiatic Cholera



Spirillum Cholerae Asiaticae. X - 1000.
From a photo-micrograph. (Koch.)



Colonies of the Cholera Spirillum.
1. End of twenty hours. 2. End of thirty hours. 3. End
of forty-eight hours. 4. After liquefaction of the
gelatine. (FLUEGGE.)



Dried and Stained Preparation of *Clostridium sporadicum*.
(1800x, from a right side, one gelatinous culture.)
(BAUMGARTEN.)



Dried and Stained Preparation of the *Clostridium sporadicum*, from a fresh non-cultured culture grown at 37° C.

Attention is called to the fact that the *Spirillum chlorae* is a very variable in its appearance and its most characteristic. Spectromicrographs from a fresh and vigorous culture may be so close and thick that only a slightly greater curvature of one side of the vibrio as to be noted as a sign of the characteristic curvature. Spectromicrographs from the same culture at 1000 magnification, showing the curved form of the vibrios in a great and striking degree. From a culture is also large as is shown in the figure on the upper right and the lower right. The vibrios are in a great number of places, and the vibrios are in a great number of places, and the vibrios are in a great number of places.

1. Gelatine culture of the Finkler-Prior vibrio, grown at the temperature of the room, four days after inoculation. A large quantity of the gelatine is liquefied and uniformly turbid.

2. Gelatine culture of the vibrio isolated by Deneke from cheese, grown at the temperature of the room, four days after inoculation. A smaller quantity of the nutrient medium is liquefied than is the case with the Finkler-Prior vibrio when grown under similar conditions.

3. Gelatine culture of the spirillum cholerae Asiatica, grown at the temperature of the room, four days after inoculation. In the small quantity of gelatine that has been liquefied along the track of the needle, a quantity of whitish granular matter can be found. Owing to the evaporation at the surface of the liquefied gelatine, a bubble of air has been drawn below the surface. The formation of such an air bubble occasionally takes place in cultures of the Finkler-Prior vibrio and other microbes.

ASIATIC CHOLERA:

ITS GENESIS, ETIOLOGICAL FACTORS,
CLINICAL HISTORY, PATHOLOGY,
AND TREATMENT

BY

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TO THE MEMORY OF
MY ESTEEMED AND BELOVED FRIEND
JOHN C. DALTON, M.D., LL.D.
IN
HOMAGE OF HIS GREAT DEVOTION TO THE ART AND SCIENCE
OF MEDICINE
IN
TESTIMONY OF THE INESTIMABLE VALUE OF HIS
SERVICES TO PHYSIOLOGY
AND IN
GRATEFUL RECOLLECTION OF MY STUDENT LIFE IN
HIS LABORATORY,
THESE LECTURES
RESPECTFULLY AND AFFECTIONATELY
ARE
INSCRIBED.

PREFACE.

These Lectures were delivered at the College of Physicians and Surgeons of Chicago, as part of a course on the Practice of Medicine, in the winter of 1892-3, in addition to the lectures belonging to my own Chair; that of Physiology. The subject matter was compiled from a great number of sources. The lectures were never intended for publication, and while they represent a considerable amount of work, no one recognizes more completely than myself, their imperfections and short-comings. My only excuse in giving them publicity is an invitation to that effect, which I received from the Graduation Class of '93, a request which I felt it to be a duty as well as a privilege to favorably respond to.

245 WARREN AVENUE, CHICAGO, ILLINOIS, MAY 25th, 1893.

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ASIATIC CHOLERA.

LECTURE I.

The study of the disease that we to-day commence, is exceptionally interesting on account of the fact that even now its shadow can be seen upon our shores, and for the past few months its ravages in the Eastern Continent have almost struck terror into the heart of civilization. Within a few months, Chicago will open her doors to the inhabitants of the globe, all nations have been invited to accept our hospitality; already the brains of architects are planning the erection of suitable buildings; already are cunning and skillful artisans at work for the Great Exposition, but vain and futile will have been our efforts, if in addition to the golden stream of wealth, that will flow from every point of the compass towards our gates, there comes the dark, noisome current of disease and death. It behooves us therefore to pay especial attention to this subject, lest peradventure the enemy steal among us and catch us unawares. You may recollect that about ten years ago, cholera swept over Asia, and Europe; you may remember its devastations in Southern France and Italy; you may bring to mind how the gallant Humbert, king of Italy, and his lovely Consort bound themselves more closely than ever to their subjects by their care and solicitude for the sick and suffer-

ing; how the King, proving himself regal by nature as well as by rank, went bravely into the infected districts and ministered to the wants of the afflicted and dying. But you do not remember, for the world does not know, the names of that host of noble men and women who as physicians and nurses not only visited, but lived in the hovels of the sick and poor, and sacrificed life itself on the altar of duty.

In reading the history of man, we find records of epidemics that at various periods, have prevailed. Sometimes these epidemics have been circumscribed in their influence, and limited to special localities; while again they have taken a wider range and extended over large sections of the earth, inflicting most lamentable results and increasing to a most alarming degree, the mortality bills of the inhabitants.

For obvious reasons in studying these early epidemics it is very difficult for us to identify the special character of the condition or disease that flourished during a given time. The earlier writers who have described them, speak in terms more or less vague, uniting however in ascribing to them fatal and devastating attributes, surpassing all other maladies by their rapid, uncontrollable advance and extension, and in the duration of their prevalence. In the Orient,—in Egypt, and along the eastern shore of the Mediterranean sea, fearful epidemics have occurred from time immemorial. They have often proved very destructive, especially in the middle ages, and as late as the sixteenth and seven-

teenth centuries. During the prevalence of the pestis, which raged throughout Europe between the years 1347 and 1350, according to computation, a fourth part of the inhabitants of that section of the globe was carried off. The estimates of the vast numbers swept away by its repeated occurrence and prevalence appear quite incredible. For example: during the time it ravaged Marseilles in 1720 it is reported that in the Charity Hospital there were admitted from October 3rd to February 28th, 1013 patients, of whom 585 died; and during the same period in another hospital, there were admitted from October to July 3rd, 1512 patients, of whom 820 died. The population of Marseilles previous to the occurrence of the disease was estimated at about 90,000, of whom 40,000 died; leaving only about 10,000 of the whole population who had not been attacked or in any way affected; so that the record shows the appalling mortality of fifty per centum of those who were attacked.

The bills of mortality in the years of 1770 and 1771 were as appalling as any arising from epidemics of later dates. Mons. Geradin investigated the "pestis" as it raged in Moscow in the year 1771, and quoting from the published statistics, observes: in April the deaths were 744; May, 851; June, 1099; July, 1708; August, 7268; September, 21401; October, 17561; November, 5235; December, 805; making a total in nine months of 56,672, which is considerably less than the estimate given by De Mertens, who thinks the whole number carried off by this pestilence, from the city alone, can not be less than

80,000. In comparing these statistics with those of epidemics of Asiatic cholera in our own time we notice a striking similarity between them; thus in Asiatic cholera the intensity of the disease varies in a given epidemic, with the season of the year; the greatest fatality being usually at the close of summer and at the beginning of autumn. We find in short many points of resemblance in this and former epidemics to that of cholera, and this naturally leads us to look upon the "pestis" as being phylogenetically related to, if not identical with cholera. While in noting the characteristics of the various diseases referred to, that in earlier times have afflicted the sons of men, we can recognize syphilis and small-pox, among others; there is no doubt in our minds as to the identity of "the white and cold death" of the earlier chroniclers with Asiatic cholera.

We are not at all surprised at the fearful moral influence these epidemics had upon the minds of the people. Their pestilential character, their extended influence, their great fatality, and their sudden appearance and uncontrollable advance rendered their presence and progress a special terror to physicians, and melancholy apprehension to the populace. They seem to have been regarded as the manifestation of an invisible power, which directed and guided "the pestilence that walketh in darkness" and "the destruction that wasteth at noon-day;" a visitation or chastisement over which human ingenuity and medical skill had little, if any control. And this belief was fostered in the people, who were

taught that the epidemic was a punishment from God-Almighty, for sins, and was to be submitted to in sorrow and with patient resignation, and to be shortened or averted only by prayer, fasting and pilgrimages. In this way, during such epidemics, the spread would be aided, as people would congregate together, and headed by priests and church dignitaries would march in solemn procession, calling upon God and his saints to withdraw the dread affliction. Under these conditions, it is not remarkable that no rational, reasonable measures could be adopted to prevent the occurrence of the malady. But our forefathers in medicine were far in advance of the rest of the people, and we find them laboring and endeavoring to satisfy the great mass of mind that these occasional and special developments of disease arose from natural causes and were subject to certain natural laws. They ascribed their origin to the commingling of some specific poison, in the food, and drink, and air, which through these "media" was received into the system. But in spite of all their efforts, we find them making but little headway. The obstacles they had to overcome were too numerous and too formidable. Superstition fostered and nurtured by interest and ignorance, constantly and most energetically led her forces against scientific medicine. Menaced on the one hand by the churchmen as being "heretics," and threatened with the direst punishments, both of this and the world to come, unflinchingly these pioneers in the art and science of our profession "kept on the even tenor of their way," and laid the foundations of the

magnificent superstructure it is our privilege today to contemplate. Even in those days though, we find men outside of the medical profession, advanced enough to recognize natural factors in connection with disease-causation, thus when Rinaldo, prince-archbishop of Cologne and Chancellor of the German empire, accompanying the Emperor Barbarossa to the siege of Rome, was interviewed by an Italian delegation friendly to the Germans, warned of the pestilential fever that every year afflicted the Romans, and asked to have public prayers offered up that it might be averted, he replied by informing them that if they would drain the Pontine marshes, and cultivate the marsh land around the Eternal City, the visitations of the Lord would soon cease.

The specific poison theory was elaborated upon by the followers of the medical art, and advances made on this line. They considered the extreme summer heat—especially the intense heat of the sun in a dry season—the emanations from stagnant waters, and the miasm exhaled from the soil, and from putrid bodies of animals, as the chief causes of all epidemics. These views prevailed for a very long period and have really undergone no very remarkable change down almost to our own time.

Modern writers advanced nearly the same doctrines, embracing however the principal sources of insalubrity—the malarious and miasmatic influences; and have assigned as the cause of epidemics, especially that of cholera, a peculiar constitution of the atmosphere, and certain predisposing causes combining with each other, so that an association or

union of these two independent and individual causes are necessary and essential to the production of the disease. Eminent scholars and pathologists have during the past century, patiently searched for its final cause, without arriving at any better, wiser, or more satisfactory conclusion than the earlier writers, who regarded it as a poison, commingled with the food they ate, the water they drank, and the air they breathed. The more modern writers almost universally adopted the hypothesis that the remote or final cause of cholera is a specific poison; for says one eminent authority: At no period has a person in good health in this or any other country been known in a few minutes to be shrivelled up, his face and extremities to turn purple, his whole body to become of an icy coldness, and with or without vomiting a peculiar fluid, like rice-water, to die in a few hours, except under the influence of poison. That this disease, so appalling and destructive in its effects and so mysterious in its wanderings, should spread over countries in respect to climate, soil, geological formations, and as to the moral and physical habits of the population, so utterly opposite to those where it first originated, is only explicable on the hypothesis of its propagation on the principle of a specific disease—poison. Such was the knowledge of the scientific world concerning the causation of cholera up to 1884, when the great Robert Koch discovered and described the specific, morbid, exciting etiological factor of the disease—the *Spirillum Cholerae Asiaticæ*.

You have noticed with me, the important part

played by our profession from earliest times, in educating the masses, and in determining the exact causes of disease as far as possible. You have seen how they had every obstruction put in their way, and I would here say to you that the end is not yet come, but an almost similar condition exists even today. It is surprising how careless men are of that priceless boon, good health, and how they will fight against all endeavors on our part to place their surroundings in the best possible sanitary condition. Look for a moment at our own country, and see how the various interests of the business world are cared for. The financial element has the Secretary of the Treasury; defensive principles are represented by the departments of War and the Navy, other interests come under the Interior department, and our foreign relations are cared for by the portfolio of State. Of late even the down trodden farmer has representation in the Cabinet: but let an attempt be made to elevate to a proper position the Department of Public Health, and irrespective of party, a host of objections will arise and certain defeat is the sure outcome. I would here pay tribute to Dr. John M. Woodworth, the organizer of the U. S. Marine-Hospital Service, who for years labored with this end in view, gallantly coming afresh to the attack after each defeat, until at last death overtook him with his much desired object as far from accomplishment as at first. And here now with cholera knocking at our doors, when a National Quarantine Bill of value was introduced into our National Legislature, instead of its being submitted

to the American Medical Association, it was given over to the representative of a local political organization, to be emasculated and cut and slashed to suit the exigencies of partisan interests. The same fight of ignorance and self-interests against knowledge and science, that prevailed during the middle ages is on to-day, you will find the same obstructions in your path, as did your forefathers, and in your labors and travels for the bettering of man, you will need the confidence of the knowledge of the impregnability of your position, for you will be repaid by those for whom you are working, by ingratitude and contempt.

Perhaps some idea of the character of Asiatic cholera may be obtained from a view of its birth-place and surroundings, and whether the locality of its irruption in 1629, or that of 1817, whence it spread over the greater part of the globe, be entitled to the unenviable distinction of fostering its gestation, concealing and protecting its birth, and nursing its infancy, is immaterial—since the similarity of these localities strikingly illustrates its cause and ultimate development.

On the north side of the Island of Java, about 6° S. Lat. and 107° E. Long., near where Jacatra belches forth her waters to join the stream of the Sundaian Straits, is situated Batavia, in the midst of swamps and marshes, surrounded by trees, dense under-growth and jungle, which prevent the exhalations from being carried off by a free circulation of the air, and render the town peculiarly obnoxious from marsh miasmata. Pass with me into the town,

and we notice all the principal streets traversed by canals planted on each side with rows of trees, and over the canals there are bridges at the end of almost every street. Into these waters is poured the filth of the entire town. In the dry season their stagnant and diminished streams emit a most intolerable stench, while in the wet season they overflow their banks, and as the waters subside they leave behind a quantity of excessively offensive slime. From these united causes you are not at all surprised to hear that Batavia has been considered the most unhealthy spot in the world, and has received the name of the store-house of disease. According to Raynal, the number of sailors and soldiers alone who died in the hospitals averaged 1,400 annually for sixty years, and the total number of deaths in twenty-two years exceeded a million of souls. The city was inclosed by a wall of coral rock, with a stream of water on each side within and without. Few Europeans, however, sleep within the town, as the night air is considered very baneful. The inhabitants, possibly as an antidote against the noxious effluvia arising from the swamps and canals, continually burn aromatic woods and resins, and scatter about a profusion of odoriferous flowers, of which there are great abundance and variety. During the period of prosperity of the Dutch East India Company, Batavia obtained the title of "Queen of the Orient," as the resources of all other districts were sacrificed to her exclusive commerce. Here in this noted locality, was the cholera bred and reared in 1629, under circumstances of great significance, admirably

adapted to convey some idea of its cause and character. But while in this delectable place the epidemic of 1629 apparently had its origin, it is in India, the land of mystery, of dense superstition and ignorance that we must look for the seeming origin of subsequent outbreaks. Since 1817, it has been endemic in India, annually reoccurring at various points, commencing generally at the beginning of the hot season, but sometimes occurring in the rainy and cold season. Its greatest proclivity to propagation is amongst populations living in low, damp situations, where people are crowded together, where from any cause their powers of resistance are reduced and especially where is impure or vitiated water-supply. Nearly all the diseases fatal in India are accompanied by profuse discharges with which the air, water, linen, bedding, closets, walls of hospitals and barracks become more or less infected; so that the "materies morbi" come into contact with all the inmates of buildings where the disease prevails.

Its origin or reappearance in 1817, is not in any respect essentially different from its earlier development on the Jacatra. You are acquainted with the course of the River Ganges; you know that like the Nile in Egypt, it flows for a long distance through a low, level country which it annually inundates. Dividing its waters about 200 miles from the sea, the delta of the Ganges commences and continues its variegated and checkered surface, until approaching the borders of the Bay of Bengal, it presents a peculiar aspect, being composed of a labyrinth of creeks and rivers, called "The Sunderbunds," with

numerous islands, covered with the profuse and rank vegetation called "jungle," affording haunts to tigers and various beasts and birds of prey. This large river, sacred to the Hindoos, is subject to an annual freshet, often rising to the height of thirty-two feet in the month of July; when all the lower parts of the country adjoining to the Ganges, as well as to the Burrumpootre, are overflowed for a width of one hundred miles; nothing appearing but villages, trees, and sites of some places that have been deserted. Now this river is a deity to the Hindoos, and its personality is to them a powerful god, and as the one longing of the true Mussulman is to make a visit to his Holy City—Mecca, so does the faithful Hindoo endeavor once in his life to make a pilgrimage to his sacred river, drink of its waters, wash away sin in its stream, and find salvation on its bosom. The Hindoo therefore saves all he can, and joining a caravan of those like unto himself, journeys across desert and plain towards the Ganges. With its members reduced by privation, enfeebled by want, hardship and colliquative diarrheas, the caravan at last halts on the shore of the Holy River. At various intervals along the banks there are wells, near to the river and filled with its waters. These wells receive the dejecta of man and beast and a portion of the filth that is poured into the main stream, and of this water the Hindoo devoutly drinks, with it he laves himself and with it he fills goat-skin bags to transport some of the beneficial fluid back to his native town for the edification and delectation of those compatriots less fortunate

that he in not having made the pilgrimage. But not only in the wells do the pilgrims bathe, but also in the river itself, and should the current wash some wight away, or should some sinner over anxious to be cleansed from sin, venture out too far in the stream, or peradventure should some one already sick and depressed, be seized with cramp and be drowned, thrice happy is his lot and his body must be left in the embraces of the River-God. It would be sacrilegious to remove the corpses of such lucky individuals from the stream, and they float along beneath the burning noon-day sun, and rot and putrefy and still further taint the water. And should pilgrims, as they do, die by dozens and by tens of dozens on the borders of the Ganges, there uncovered except by the canopy of Heaven itself, are the bodies left. And the living drink of, and bathe in this same water, and carry of it back to their homes.

Up from the dark Plutonian caverns of Erebus, up from the clouded Stygian valley, up from the depths of hell, in the early part of this century, arose the Goddess of Filth, and she wandered around over the face of the globe, seeking for a home to her liking. And coming to the delta of the Ganges, in this low, insalubrious and festering locality, where so many noxious and noisome diseases are generated, and where so many epidemics have arisen and so often swept over the earth with most fatal and desolating effects, - here she met, one dark and stifling night, with gaunt Despair. And surrounding her with his bony arms, Despair threw her on the foul, dark and slimy ground, and had his will of her.

And when the day of her reckoning was reached, here in the neighborhood of Jessore—a town in the centre of the delta—in agony and in shame and in desolation, Filth gave birth to the monstrosity yecept, —Asiatic Cholera. And here she nurtured and fed him, here in this vast pest-house where every conceivable vegetable and animal substance is left upon the soil to rot in the heat and dews of a tropical climate, here Filth fed her offspring from her own breasts, and as he grew and waxed strong, and his tusks and teeth appeared so that he would chew and tear her dugs, she longed to wean him, and one day as he ferociously fastened himself upon her, she cast him away on the mud, and as his mouth was forcibly torn from the dug, some of her foul milk was scattered around, and falling into the water of the Ganges, as drops, was at once coagulated by the water, and became the *Spirilla Cholerae Asiaticæ*.

Let us now take up the consideration of the great epidemic of 1817, and after viewing in a more or less cursory manner its track and mortality, I will call your attention to some points connected with the epidemic of last year. The disease in 1817 appeared on the delta of the Ganges, and gradually extending its influence, swept over various countries with terrible severity. Having here acquired its full development, and manifesting an indomitable determination to itinerate, it started upon its lethæan errand, and soon showed both capacity and power to overcome every obstacle opposed to its progress, and to pursue its course unchecked and even unretarded by any natural or artificial barrier. It soon

traversed India, and in the succeeding season spread over adjacent countries, visiting in 1818 the Indian Peninsula, the Burmese Empire, the Kingdom of Aracan, and the Peninsula of Malacca. In 1819 it reached Sumatra, Singapore, and various other islands situated along the coast on either border of this vast peninsula.

During the year 1820, pursuing steadily its progress eastward, it reached Tonquin, Southern China, Canton, the Philippine and numerous other places and islands in that direction. In 1821 it visited Java the place of its earlier nativity Maduro, Borneo, and many other places in the Indian Archipelago. During the years 1822, 1823 and 1824, it continued to spread over the vast and populous regions of Central and Northern China and the numerous islands upon the coast, and in 1827 prevailed in Chinese Tartary, leaving few places in all these different countries on the continent, or even on the islands bordering on the eastern coast, unscathed by its terrible ravages and depopulating influence.

During the same period, its progress westward was uninterrupted, and attended with results no less remarkable. It baffled all attempts to check or even retard its outward course, or mitigate its appalling effects. In July, 1821, it had reached Muscat in Arabia, and thence extended its influence to the populous cities and villages along the Persian Gulf. During the same season it appeared in Persia and continued to ravage the principal cities and towns of that empire for four successive years. At Bassorah and Bagdad it broke out in July, 1821, and thence

extended its desolations westward to the Red and Mediterranean Seas, carrying off vast numbers of the inhabitants of the populous cities of Mesopotamia, Syria and Judea.

In 1822 it prevailed among the nomadic tribes in Central Asia and in the northern Persian provinces, and in 1823 broke out on the Georgian frontiers of Russia, at Orenburg on the River Ural, and at Astrachan on the Volga. Here its western course was apparently interrupted. There was for a short period an interval of comparative immunity from its presence. Along the border of the Russian Provinces the disease had entirely disappeared, and seemed inclined to retrace its course and return to the home of its birth. But the fond anticipations of Europeans were disappointed; the destroyer was not to be arrested and turned back in his progress over the earth; his march was onward, his demands imperative. Hence, in the month of June, 1830, the scourge reappeared in a Persian province on the southern shore of the Caspian, and again at Astrachan, on the Volga in July, where it raged with such unwonted violence, that before the close of August, more than four thousand persons had fallen victims to its maleficence in the city, and twenty-one thousand, two hundred and seventy in the province. From its interval of repose, it recuperated its strength and vigor and with renewed energy, ascended the Volga, reached Moscow, became epidemic there in September, and continued with great severity until February, 1831. Here it attacked in the city about nine thousand of the inhabitants, of

whom more than one-half died. Continuing its advance, it reached Riga about the middle of May, and St. Petersburg on the 26th of June.

From Astrachan it also directed its course towards the northern coast of the Black Sea, and thence along the course of the rivers into the central parts of Russia. It reached Poland in January, 1831, accompanied the army of the Tsar, in its various marches and encampments during the dismemberment and subjugation of that country, and proved very destructive in Warsaw and many other places during April and May. It appeared at Dantzic in May, and in June at Lemburg, Cracow and various other places and sections of country, extending through Galicia and Hungary, and reaching Berlin and Hamburg in August and September, and Vienna about the same time. Smyrna was visited in September and Constantinople soon afterward. From Mecca to Cairo the pestilence was conveyed in August, 1831, by a caravan, which was known to the survivors as the "Caravan of the Path of Death," as its track was marked across the sands by some thousands of its members, who died, and whose bodies were left by the roadside; and by the middle of September, ten thousand, four hundred Mohammedans, besides Jews and Christians, had died of it in this latter city. Passing from the western coast of the Continent, on nearly the same parallels of latitude, it found its way over the north sea to the British Isles, and making a lodgement first on the northeastern coast of England, in October, 1831, appeared at Sunderland, situated in latitude 55°

north, whence it prevailed and extended its influence over this section, evincing the same malignant character it had manifested in its progress over the Continent. It made its first appearance in Scotland, at Haddington in December, 1831, and at Edinburgh in January. In these and various other places it manifested its energy, and warm weather coming on, it increased in severity, and carried off a large percentage of those attacked. After spreading thus over the northern section, and rioting for months in the more populous cities and towns, it made its entry into London on the 14th of February, 1832, where it found abundance of material for recuperating its strength and multiplying its forces, and soon after spread over various other places in the United Kingdom, inflicting the most appalling consequences upon the people. In short, all along we find its progress attended with most lamentable consequences and destructive influences, both on the Continent and in the British Isles. No change, modification or softening of its disposition or character had arisen from its passage over the Northern Sea, nor from the refreshing influences of a purer atmosphere.

It appeared in Calais on the 12th, and at Paris on the 26th of March, 1832, where it continued in these and other neighboring cities and towns and villages, with its accustomed vigor, for some months. During the season it raged throughout the vast empire, swept away an immense number of its inhabitants, and during the succeeding years, 1833 and 1834 it traversed Spain and severely scourged her sons and daughters.

In the meantime, continuing its course from Great

Britain westward unchecked by the prevailing western winds and the broad expanse of the Atlantic Ocean, over which it passed a distance of nearly three thousand miles, it made its first appearance on the American Continent at Quebec, Lower Canada, on the 8th of June, 1832, and arrived at Montreal on the tenth day of the same month. From here it rapidly spread in all directions, invading the towns and villages on the St. Lawrence and its tributaries, and soon extended along the chain of lakes that divides the English possessions from the United States, visiting with great impartiality, the principal ports on either shore. In all these places it exhibited the same virulence of character we have before noticed, and proved itself severe and fatal where ever it appeared.

Sixteen days after its appearance in Quebec, on the 24th of June, 1832, it broke out in New York, and at Albany, midway between the two former cities, cases were reported on the 3d of July. From New York it extended to Flatbush and Gravesend, Long Island, where it appeared on the 5th of July, and on the same day and date at the city of Philadelphia. Shortly after it was passing through New Jersey, and on the 12th of July reached Rochester, and a few days later, Buffalo, N. Y.

Thus while it was making its way westward along the great lakes, towards the arteries of the great West, it was at the same time, pursuing its course steadily along the Coast, visiting the main cities and spreading from these as from common centres over the intermediate towns and villages. In its progress it

reached Baltimore on the 22d of August and the city of Washington on the 28th of the same month. Thence it continued its course to Richmond, Norfolk, Edenton and various other cities along the Atlantic and Gulf Coast.

It appeared at New Orleans in the Autumn of 1832, during the existence of a severe epidemic of yellow fever, and apparently subsided on the disappearance of the fever. Sporadic cases, however, occurred during the Winter, and with the opening of Spring it broke out with unwonted intensity and severity, and thence spread according to its accustomed laws of itineracy, along the rivers into the interior of the States bordering upon the Mississippi and the Gulf Coast, and raged throughout Louisiana and Texas.

In 1832, 1833 and 1834 it prevailed along the Mississippi valley with great fatality, especially in the principal cities, villages and towns situated upon its navigable waters. Here after intervals of entire immunity from its presence, it occasionally reappeared in some of the larger cities with increased intensity and in short spaces of time, swept away great numbers of people. In no section of the United States did greater numbers, compared with the whole population, fall victims to it than in the fertile and sparsely settled prairies of the South and West.

Thus from the North, and at a later date from the South, extending its influence along the principal rivers into the interior, it swept over the country, being found in some places in the valley of the Father of Waters as late as 1836. In short, it reappeared in 1834 in many cities and places where it had before

prevailed, and again spread over a considerable portion of the country with unprecedented fatality.

In 1833, cholera appeared at Havana in Cuba, and in Matanzas, lasting on the island for several months with great severity, especially among the colored people. During the same season it appeared in August at Tampico, Campeachy, Vera Cruz and the city of Mexico, proving particularly violent. In Central America it is said to have attacked the army, and in a short period to have wiped out of existence a very large proportion of its officers and men.

Thus it appears that this epidemic from its first irruption on the Northern Coast, spread over the greater part of the North American Continent in the space of two years, and that it several times reappeared in different parts of the country spreading on each occasion over a greater or lesser extent of territory, with the same uniform and destructive influence. For years and years after its final departure, this epidemic left a cloud over the country, and for a long time old inhabitants spoke with bated breath of its devastations. I remember hearing Prof. Alonzo Clark, tell of its invasion of New York; how business was suspended, how the streets were deserted, how between the cobble stones on Broadway blades of grass put up their little heads into the sunshine, how houses were closed, and a funereal pall seemed to hang over the Empire City. Then one could walk out in the early morning, when the air would be bright and cool and pure and apparently salubrious, and security and peace seemed to hover over the

city; but reminders of the true condition would be noticed in the appearance of carriages loaded with household utensils tending toward the country, by the odor of vinegar with which every passer by was accompanied, and by the mournful creaking of the wagon conveying some one to the small and narrow house. The public parks were cool and fragrant as of yore, skirted by verdure as bright and shaded by foliage as luxuriant, but no longer frequented by lively steps and cheerful countenances. Every day added to the devastation and confusion of the city. The most populous streets were deserted and silent. The greater number of the inhabitants had fled, and the ones who remained were occupied with no cares but those which related to their own safety. The work of the artisan and the speculations of the merchant were suspended, but the labors of the physician were increased many hundred-fold. All shops, but those of the apothecaries, were closed. The hearse was now the only carriage seen, and this was employed, night and day, in the removal of the dead. The customary sources of subsistence were cut off. Those, whose fortunes enabled them, had left the city, and those who lived by the fruits of their daily labor were subjected, in this total inactivity, to the alternative of starving, or of subsisting upon public charity. I remember hearing the Doctor tell of one particular day when he walked forth in a residence street, which was as quiet almost as a grave-yard, the only sound heard being the rattle of the dead wagon stopping at one house or another for its ghastly freight. Slowly he strolled along, feeling intensely

the deep solemnity of his surroundings, when the door of one of the houses opened, and a young woman came out talking to a companion, and suddenly laughed. At any other time her laugh would have been called soft and musical, but now it sounded harsh, and wanton and weird. And Clark said he thought of the words of the Prophet: "I also will laugh at your calamity; I will mock when your fear cometh. When your fear cometh as desolation, and your destruction cometh as a whirlwind; when distress and anguish cometh upon you."

LECTURE II.

At my last lecture, I outlined to you, some matters connected with the history of great epidemics that in earlier times, have visited our planet, and the course of the great cholera epidemic of 1817. This plague, as we have already noticed, was marked by great severity and high rate of mortality. According to the most reliable reports, the cases occurring in the earlier periods of an irruption are generally fatal, few only surviving the attack; while of those occurring when the disease is on the decline, a greater number recover. Some observers have divided epidemics in three subdivisions; the first, in which the majority of the cases die; the middle third, in which many die and many recover; and the last third, in which the larger number of the attacked, recover. This arbitrary rule however can not be looked upon as being generally applicable, as you will find in studying the various outbreaks of cholera, that often the disease will seemingly be of equal virulence all throughout an epidemic, and will suddenly disappear, to re-appear perhaps in a week or a month, as malignant as in the first invasion.

We read of numerous instances where one-third, one-half, two-thirds and even nine-tenths of those seized with cholera have perished, and again of some places where one-fifth, one-fourth, and in some attacks one-third of entire populations have been cut off in a very short period by it. But without attempt-

ing to burden your minds with statistics of cholera, in this part of the world, or even in Europe, I will present to you a few instances of mortality, in order to show the severity of the disease and the necessity for prophylactic study.

During the epidemic of 1817, in Siam, it is said, 20,000 persons fell victims to it in twelve days. The Siamese are remarkable for their disregard of sanitation.

In Sicily, 16,000 died of cholera in 1832, at Catania; in Palermo, 40,000. In Bassorah and Bagdad, situate in low, unhealthy localities, and exposed to a damp, insalubrious atmosphere, which in the warmer season is often essentially impregnated with miasmata and offensive exhalations from animal and vegetable decomposition, both within and without their inclosures, it is affirmed that more than one-third of their entire populations were carried off in less than a month.

In the province of Caucasus, out of 16,000 attacked by the disease 10,000 died. In Russia, out of 54,000 attacked in 1830, it is said more than 31,000 succumbed.

In Hungary, it is reported that the whole number affected by the disease was about 400,000, of whom more than one-half died.

It is officially reported that the total number—the military excepted—of those affected with cholera in France, from its first appearance at Calais, March 15th, 1832, to January 1st, 1833, was 230,000, and the deaths were 95,000.

In England, the whole number of cases of cholera

was reported to have been 49,594 and the number of deaths 14,807. In the City of London there were 11,020 cases, of which 5,274 proved fatal. In Wales there were 1,436 cases, of which 498 died. In Ireland, from its first appearance in 1832 to March, 1833, there had occurred 54,552 cases of which 21,171 were fatal.

In Quebec, from June 9th to September 2nd, 1832, there had occurred in that city alone no less than 5,783 cases, of which 2,218 were fatal. In Montreal from June 10th to September 21st, there were 4,440 cases, and 1,904 deaths reported.

In New York, from July 4th to August 28 in 1832, there had occurred 5,814 cases, and 2,935 deaths. In Philadelphia, from July 4th, to August 28th, 1832, there were reported 2,314 cases of cholera, of which 935 were fatal.

In many particular portions of the United States, the percentage of loss from cholera, during this and other epidemics, was considerably higher than the general average compared with the data I have given you. The mortality varies materially in different localities, and indeed, I feel safe in saying, is in direct ratio with the sanitary condition, of the **locality in question.**

Since the occurrence of the epidemic whose course and peculiarities, we have just reviewed, this part of the world has been visited at various intervals by Asiatic cholera. Prominent periods were the years 1848, 1854 and 1866. It is now almost ten years since we have been threatened by it. You recollect that then it was endemic in several portions of the

country, and I believe would have become generally epidemic, had it not been for the promptness and energy of Surgeon-General John B. Hamilton, who proved himself to be a sanitarian and hygienist of great skill, by the manner in which he handled the threatening danger. The route of the epidemic of 1892 has been carefully traced by Dr. Dawson Williams, of London, from whose paper read before the annual congress of the Sanitary Institute, September 1892, we learn as follows: In tracing the progress of the present epidemic of cholera, it does not appear to be necessary to include a consideration of the occurrence of the disease in Syria in 1891, or its subsequent recrudescence. There is no evidence of any spread from Syria either northward or westward; on the contrary, all the evidence goes to show that Asiatic cholera reached Europe in 1892 by a track differing altogether from the paths followed in the last half century, though nearly approaching the route taken by the earliest epidemics which reached England.

Speaking broadly, Asiatic cholera has followed three main routes from India to Western Europe: 1. It has passed through the north-west provinces of India into Afghanistan, and thence along the caravan routes by way of Balkh, Bokhara and Khiva to Orenburg in Russia (1829, 1843-44); 2. It has spread from Southern India up the Gulf to Persia, and radiated south-westward to Syria and Egypt, and north-westward across Persia to the Caspian Sea, thence to Astrakhan on its western shore, and from that port up the Volga to Saratov and Kasan (1830);

3. It has been transported, mainly in relation with the pilgrim traffic, to Red Sea ports, has gained Egypt, and spread thence to the Mediterranean basin. Since 1865 the epidemic has always, until 1892 taken the last mentioned route, and the attention of international conferences has been, in the main, confined to devising precautions for protecting Europe from invasion by way of the Red Sea and Egypt.

In 1892, the epidemic once more followed a northern course, and has afforded one more striking illustration of the readiness with which Asiatic cholera can be conveyed along a trade route.

Late in 1891, cholera appeared in Afghanistan, and caused a considerable mortality in Cabul. During the winter months, January and February, the epidemic died down, but in March there was a severe outburst, and the disease continued to be epidemic for several months. In March the disease had reached Herat, in north-western Afghanistan, and was causing several hundred deaths a day. Two months later it had become established in Meshed, in north-eastern Persia, and spread slowly thence to Nishapur, Gabzawar, Abbasad and Sharud, only becoming epidemic at Teheran some two or three months after its appearance in Meshed.

Very different from this slow march of the epidemic westward through Persia, was its swift progress once it touched Russian territory. The disease was recognized at Askabad during the first day of June, having in all probability spread there from Meshed a little earlier. At Askabad the epidemic touched the Trans-Caspian Railway, which runs from the

eastern shore of the Caspian Sea, through Askabad and Merv to Bokhara and Samarkand. Cholera spread eastward and westward along the course of the railway with great rapidity, nor was its progress arrested or even checked by the Caspian Sea, for its presence in Baku on the western shore was admitted officially within a fortnight of its recognition in Askabad, and private telegrams show that it had undoubtedly been present for a week or ten days before this. Baku is an important trade centre. It is the terminus of the Trans-Caucasian Railway, which brings it into direct communication with Black Sea ports, while steamboats on the Caspian connect it with the terminus of the Trans-Caspian Railway, and with Astrakhan, the southern outlet of the trade of the Volga. The spread of the epidemic in Baku itself, favored by the existence of gross sanitary defects, and by the want of competent municipal government, was rapid; and even the brief telegraphic despatches have given a picture of social disorganization which can hardly be equalled in the whole terrible gallery which Asiatic cholera has provided for the warning and instruction of mankind.

With cholera raging in Baku, and with an inept administration relying entirely upon quarantine regulations illogically planned and imperfectly carried out, it was no matter of surprise that the epidemic found its way eastward along the Trans-Caspian Railway as far as Tiflis, and northward by the Caspian boats to Astrakhan. How early the last named city was infected is not, and probably never will be, known; when the presence of the

epidemic was recognized officially, it was already prevailing in Saratov, some 500 miles higher up the river, and a week later was reported from Kostroma **to the north-east of Moscow.**

Within a month, therefore, of the recognition of cholera at a town on the Trans-Caspian Railway, it had penetrated to the heart of Russia in Europe, the transit from Central Asia having taken as many days as, before the creation of railroads and steam-boat lines, it took months. The recognition of the significance of this fact is one of the most important lessons which this epidemic has as yet afforded.

Having traced the progress of the epidemic from Afghanistan to Persia with great probability, and from Persia to Russia in Asia, and from Russia in Asia to Russia in Europe with precision, it remains to enquire how the infection reached Afghanistan. As to this there is room for some difference of opinion. It is natural in the first place, to turn our thoughts to the Hurdwâr Fair, the continuance of which the Indian Government found it advisable last year to prohibit, on account of the danger of the dissemination of cholera. This great assembly of people, brought together primarily by a religious object, is frequented by pilgrims and traders from the north-west provinces, by Kashmirees and border men. The prohibition was not completely effective, and many of those who reached Hurdwâr at an early date, eluded the vigilance of the officials at a later, undoubtedly carried cholera for considerable distances. There is strong reason to believe, though the fact cannot be affirmed positively, that the disease

was thus conveyed to Srinagar, the capital of Kashmir, where a severe outbreak began in May. While it will be admitted that the accumulation of a huge multitude of people at Hurdwar in the early Spring, and their dispersal in every direction throughout north-western India and the frontier countries, is a fact, the significance of which for Europe is greatly increased by the proof now afforded that cholera may be carried in a few weeks from the confines of Afghanistan to European Russia, yet it appears that the Hurdwâr Fair is not in any way responsible for the movement of cholera last year.

As we have already seen, cholera was epidemic in Afghanistan at the end of 1891. A month or two earlier—in September—an outbreak had occurred among laborers in the Hoti Mardan district of the Peshawar division. There appears to be little doubt that this outbreak was originated by men coming from Swat and other independent territories to the north-east of Peshawar. The laborers immediately dispersed, many fleeing to Peshawar, where an epidemic of a peculiarly fatal character subsequently occurred, both in the town and in the Pathan villages in the immediate neighborhood. The mortality in some of the villages in the valleys toward the eastern mouth of the Khyber Pass was particularly severe. At an later date many villages in the Shinwarri country lying to the north of the western end of the Pass were ravaged, and toward the end of the year Cabul itself was attacked, as already said.

It does not seem to be necessary to refer at any length, to the spread of the epidemic at Hamburg;

its dependence upon the line of emigration from Russia appears to be obvious, and the probability of the occurrence of cases among emigrants arriving at that port from infected districts *en route* for England and America ought to have been foreseen and provided for by the authorities in Hamburg. This does not seem to have been the case and insanitary conditions appear to have been allowed to prevail, of which we now see the inevitable consequences. Neither does it come within the scope of our present studies to discuss the nature of the choleraic disease which began to prevail in Paris in the early Summer. Its epidemiological characters were not those of Asiatic cholera.

From our studies of this epidemic, the following deductions may be made: 1st. The greater rapidity of transit has increased the probability of the importation of cholera and other epidemic diseases from central Asian countries to European Russia, and thence to Europe in general. By extension of commerce, and the building of railways, and steamer lines, the land of dense religious superstition, of unqualified ignorance, and of total disregard for sanitary laws, has been brought in close and intimate relations with the civilized world. This condition is well exemplified by the fact that a trip from Chicago to Irkoutsk, is thought less of to-day by us than was a journey from Philadelphia to Washington, less than a hundred years ago, by our forefathers.

2nd. Asiatic cholera, in traveling by land routes, depends for its power of continued progress mainly upon the existence of insanitary conditions in towns

in which traffic is temporarily arrested for transshipment or otherwise. The necessary delay affords time for persons from infected districts to be attacked by the disease, and so to infect the place at which the halt is made. Such places become fresh centres from which the disease spreads along lines of traffic. This fact is well illustrated by the history of the epidemic in Baku and in Hamburg. Cholera spreads to an extent and with a rapidity directly proportionate to the march of commerce and the facilities afforded for intercommunication. Its intensity and reactionary strength are in direct ratio to the sanitary condition of the locality, and the manner in which hygienic laws are obeyed, or disregarded, and in this connection let me call your attention to the parable spoken of in the Scriptures, of the sower and his seed, and of the different results obtained in accordance with the condition of the receiving ground; so with cholera, and all filth diseases, let the territory be acceptable and the harvest will be plenteous. Let the ground be nutritious and the disease germs will take root rapidly, and grow and develop with malignant luxuriance.

3rd. Quarantine has once more shown itself to be a most ineffectual method of checking the spread of cholera. Quarantine for instance, between Baku and Astrakhan utterly failed to prevent the spread of the infection to the latter town. Quarantine is therefore in one way, dangerous, because it leads to a sense of false security. That is, quarantine alone, and without other precautions.

4th. On the other hand, medical inspection of

travelers, especially of those of the poorer emigrant class, combined with isolation of doubtful cases, appears to be once more showing itself to be an effectual method. At the same time, it must be recognized that no method can be effectual in the absence of good sanitary conditions in ports or other centres of trans-shipment or temporary arrest of trade. In fact, it may truthfully be said that the only effectual method of excluding cholera from a country is to exclude the infectious principles from its water supplies.

5th. There is great need for more precise, earlier, and more authoritative information as to the existence of epidemic diseases in all civilized countries. Such information, is at present, as it has been in the past, eminently unsatisfactory. Information coming from scientific journals, from government reports, while precise and authoritative, comes too late to be of service during a given epidemic. Newspaper reports, on the other hand, while prompt, are not reliable, as they usually are founded on either popular rumor, or on official statistics which are not always entirely trustworthy.

I will consider that these lectures have not been delivered in vain if I can indelibly impress upon your memories the following facts: Local quarantine is an absurdity. The quarantine regulations and public health laws, should be in the hands of National authority, to be of value to the country, or in fact to any part of it. Chicago and Omaha are, from a commercial standpoint, as much seaports as New York or Boston. Denver is as near to the

Orient as is San Francisco, and it is just as nonsensical for the State of Illinois to have charge of quarantine regulations concerning her own territory, as it would be for her to declare war against the German Empire. But in order to attain the much desired end, we must continue the campaign of education, that was begun when the first physician commenced to practice medicine. On you, the physicians of the future, will devolve the task that we of to-day will be obliged to resign as our strength wanes, and your first step will be to show clearly to mankind that financial interests require the observance of sanitary laws. It is therefore to the advancement of commerce to enforce hygienic regulations. Of what benefit would it be to the Garden-City, with the Exposition in full blast, with great expectations and hopes not only to be immediately realized, but to be felt in both near and distant future, if the pestilence should come among us? It is to our financial and commercial interests therefore to be clean physically as well as morally. The wise man hath said: "Cleanliness is next to Godliness," but I place cleanliness first. How can a pure spirit reside in a foul and filthy body? How can a virtuous maid make her home in a brothel? We should, irrespective of political belief or partisan prejudice, bend our energies in this direction; to have all quarantine and public health matters under the control of the Federal Government; to endeavor to have a Portfolio of Public Health attached to the Cabinet of the Chief Executive of the Nation, in charge of a medical man whose recommendation for the position

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must be that he is a scientific physician and a skillful sanitarian. When this condition of affairs shall come to pass, then we can absolutely prevent invasion of the Commonwealth by foreign epidemics, and quickly stamp out those due to auto-infection.

Asiatic cholera is a specific, infectious disease, induced by a specific, exciting etiological factor acting under the influence of favorable contributory conditions, and characterized clinically by violent purging, great dessication of the system, and rapid collapse. You will note that in this definition I make mention of a particular cause, which we have before referred to as the spirillum cholerae Asiaticæ—Koch's comma bacillus, and I would accentuate the value of our knowledge in this direction, as without such information, prophylactic measures would be entirely empirical, and could not be scientifically applied. An old and trite proverb says: "You must first catch your hare before you can cook him," but in order to catch the aforesaid hare, you must first know something concerning his habits and mode of life, his peculiarities and characteristics. In the chronicles of Ibrahim El Mured, I find the following legend: During the reign of the great and good Caliph Haroun-Al-Raschid of happy memory, there dwelt in the city of Bagdad, a follower of the Prophet who was renowned far and near for his wisdom, so that even from the most distant portions of the Caliph's dominions, people would come to Bagdad to consult the wise-man. Now it happened that in a far and distant city, the inhabitants were sorely afflicted on account of a certain monster

which for many months had been ravaging the vineyards and grain fields, working grievous damage and occasioning great distress. The people of this city having heard of the wizard at Bagdad, came together and sent a messenger with presents, to obtain instruction as to how they might best free themselves from the monster who was plaguing them. And after forty days' journey, the envoy arrived at Bagdad, and having performed his ablutions, he presented himself before the man of wisdom, and stated his case. Then said the philosopher: "What manner of beast is this that you complain of?" and the youth blushingly acknowledged that neither he nor any in the city had as yet laid eyes upon it. "Then, by the beard of the Prophet," exclaimed the wiseman, "how can I instruct thee how to rid thy town of its persecutor. Go back, Oh, most foolish of messengers, and acquaint thyself with what manner of beast this may be, and then when thou shalt come and tell me whether it flieth in the air, or walketh on the ground, or swimmeth in the water, then can I tell of cunning means I will devise for its destruction." And the messenger departed, a sadder and a wiser man.

Following out this mode, or plan, we will now commence the study of the etiology of cholera. In 1883, Robert Koch went out to Egypt as chief of a commission sent by the German government to investigate the causative factors of cholera. From Egypt, the commission subsequently went to India, continuing their observations, and in 1884, Koch announced to the world his discovery of the "Comma-

Bacillus." That this micro-organism is the exciting cause of the disease, there is no doubt. It responds to all the tests to which a micro-organism must respond before it can be called "specific." It is always found in the bodies of those suffering from Asiatic cholera; it will grow and develop in culture-media outside the body; from these media, the disease can be reproduced; and in those animals in which the malady has been reproduced, the specific morbid, **micro-organism, can be found.**

Koch was first struck by the discrepancies between the descriptions given in the text-books of the post-mortem appearances of the disease, and the appearances he actually found. He noticed that it was rare to find the intestinal mucous membrane simply opaque with slightly swelled follicles and the tube containing gruel-like material. This condition he found only in the most acute cases, and the gruel-like matter presented the characteristics of an almost pure cultivation of the bacillus. Very exceptionally did he find fluid in the intestines, comparable with rice-water. In cases where the disease had lasted somewhat longer, he noticed that the follicular masses and Peyerian patches were surrounded by hyperemic rings or zones, having a tendency to run together into red patches; and in the cases where the disease had lasted the longest, he found the small intestine congested, most marked above the valve, the contents becoming bloody, exhaling a putrefactive odor, and with the replacement of the before-referred to bacillus, by other bacterial forms.

If, in the stage of patchy redness, sections were

made of the mucosa parallel to its surface, it was shown that the redness corresponded to an invasion of the tubular glandular structures, by the bacillus found in the contents of the intestine in the more acute cases, and the parasite was found lying between the epithelium and the basement membrane. On account of its definite form, and its apparent constant presence, the parasite soon attracted attention. When he wrote his early papers on this subject, Koch named the parasite "the comma-bacillus," and he believed that its form was quite characteristic. Some bacteriologists speak of it as the cholera "vibrio," but Sternberg following Flugge's nomenclature calls it the "*spirillum cholerae Asiaticæ*," and it is by this name, we shall study and recognize it. This micro-organism is about one-half to two-thirds the length of a tubercle bacillus, but much thicker (about .5 m.m.m.) and it presents a curve, usually about equal to that of a comma (hence the first name comma bacillus), but sometimes amounting to a semi-circle. It multiplies by transverse division, and the segments separate from each other at once upon gelatinous media or in the intestine mucosa; if two remain united they form an "S," their curves being in opposite directions. Under certain circumstances it grows out into long spiral filaments, and the so-called "commas" have a spiral twist which may be recognized in drop cultures, especially in the longer elements which in stained preparations present an "S" shape. When development is rapid the short curved rods and "S" shaped spirals only are seen; but in hanging drop cultures, or in media in which

the development is retarded by unfavorable conditions, such as low temperature or the presence of a small amount of alcohol, long spiral filaments are quite numerous. In old cultures, the involution forms or distorted forms, are often seen. The curved rods have rounded ends and are about 0.3 to 0.4 m.m.m. in diameter. They are actively motile, and are provided with a single terminal flagellum, which however can only be demonstrated by Löffler's staining methods. The above mentioned spirals resemble very much the spirillum of Obermeier, in fact side by side under the microscope, Koch found it difficult, if not impossible, to distinguish between them. The cholera spirillum grows well upon all the ordinary media, and its rapid multiplication can be watched in a drop of meat-infusion upon the under surface of a cover glass. In stains of cholera dejecta upon linen, kept moist and exposed to the air, growth is quite free for several days. The colonies upon nutrient gelatine or agar begin as very tiny, pale spots, which, as they get larger, present a slightly irregular outline and a finely granular surface; Koch compares them to heaps of fine bits of glass. Then the gelatine (not agar) around for about one millimeter liquefies and the colony sinks down into a funnel-shaped depression with an apical white point. This appearance of a long narrow funnel is typical when a tube is inoculated by puncture. The growth of this spirillum is unusually rapid; it reaches its limit in a few days, remaining a short time stationary, and then begins to decline, the spirilla either shrivelling or swelling up centrally or

terminally, and staining more or less imperfectly.

Concerning the etiological relation of the spirillum to the disease with which it is associated, I have already commented. So eminent an authority as Surgeon-General Sternberg of the U. S. Army, states that so far as his information extends, there has been no failure to find it in the characteristic discharges of cholera patients when these have been collected at an early period of the attack and have been examined by competent bacteriologists. On the other hand, this particular micro-organism has never been obtained from the alvine discharges of persons suffering from other diseases, or of healthy individuals, although very extended observations have been made on this line, since the announcement of Koch's discovery. Prominent among these are the researches of Finkler and Prior, of Weisser, of Escherich, of Booker, of Jeffries and of Sternberg. For full information in this connection I must refer you to Geo. M. Sternberg's works, from which I largely quote. Examinations have been made of the dejecta of those suffering from enteric fever, and of well and river water from various sources, but no one has met a spirillum which is identical with the "comma-bacillus" of Koch. This subject is, at the same time, one of public health and of microbiology, and nothing is more attractive to-day than microbiology, especially that of all those maladies which are variously termed Asiatic cholera, cholera nostras, cholerine, choleriform diarrhea. The intestine is, in all of these different cases, infected by microbes to which are attributed *cholerigenic* properties. And

here I will enumerate these bacilli, which are in brief: 1st. The comma-bacillus of Dr. Koch discovered by him at the time of the Egyptian epidemic in 1883, and the existence of which has been recently confirmed at Hamburg; 2nd. The bacillus which Emmerich observed in 1884, during the epidemic at Naples; 3rd. The bacillus of Drs. Finkler and Prior; 4th. The bacillus which Drs. Gilbert and Girode observed in several cases of cholera alleged to be *nostras* and which in the opinion of many bacteriologists, is no other than the bacterium coli commune; 5th. The micro-organism obtained in 1885, by Deneke, from a piece of old cheese. Of these, two are in some ways, found to be closely allied to the Koch spirillum; one, the spirillum of Finkler and Prior, and the other, the spirillum of Deneke; but both of these have been shown to present constant characters by which they may be differentiated from the spirillum cholerae Asiaticæ. Cunningham, as a result of recent researches made in Calcutta, states that he has failed to find comma bacilli in undoubted cases of cholera, and that in certain cases in which they were present he was able to differentiate several varieties. The question of cholera microbiology, is not by any means as yet entirely settled, although there is no doubt of the specific value of the comma-bacillus.

Professor M. Nencki reports under date of January 7th, 1893, on the work accomplished in the St. Petersburg Imperial Institute of Experimental Medicine during the cholera epidemic of last year. At the very beginning of the outbreak the institute was enabled, by the kindness of Prince Alexander of

Oldenburg, to establish two temporary branches for practical work at Baku and at Astrakhan, and to furnish them with the necessary apparatus and instruments for bacteriological investigation, as well as with a large supply of old and new remedies for the disease. As a result of these investigations, Dr. Blachstein and Dr. Shubenko advance the following: They found in the stools of a large number of patients suffering from typhoid-cholera, and sometimes also in cases of typical cholera three kinds of short bacilli, which they named bacterium caspicum alpha, beta primus, and beta secundus. The bacterium caspicum alpha does not liquefy gelatine. It is very difficult to distinguish this bacterium from the bacterium coli commune and from the bacillus of enteric fever. The bacterium caspicum beta primus is chiefly found in cases of typhoid cholera, but now and then also in typical cases of cholera Asiatica. It liquefies gelatine. The bacterium caspicum beta secundus was obtained from the contents of the small intestine of a person who died from typical cholera. It acts on gelatine like the foregoing, from which it differs very little, and it is possible that both the kinds last mentioned are identical. Dr. Blachstein states that, after subcutaneous injections of bouillon inoculated with the discharges of a cholera patient, mice and rabbits died in twenty-four to thirty-six hours. On the other hand, injections of a pure culture of comma bacilli or of pure cultures of the three species of caspic bacilli, taken separately, did not cause death. This observation is in accordance with that previously made by Bouchard. Dr. Blachstein prepared

artificially pathogenic mixtures in which the comma bacillus and some of the other kinds of intestinal bacilli were present. These mixed cultures were obtained either by inoculating a twenty-four hours' old culture of one of the other microbes with the comma bacillus, or by placing one of the other bacilli in a culture of comma bacillus, and it was observed that mixtures obtained in the former way were more virulent than those prepared in the latter. Experiments on mice always gave uniform and positive results, illustrating the fact that the comma bacillus, in combination with some of a large number of other bacteria, is able to kill mice, while, in the same animals, pure cultures of any single kind give negative results.

The caspic bacillus alpha, plus comma bacillus, kills rabbits and pigeons; bacillus caspicus beta secundus plus comma bacillus kills only mice and guinea-pigs. The mixed cultures were generally injected in the quantity of 0.1 cubic centimetre into the mice; the rabbits were inoculated with two cubic centimetres. Death quickly ensued, generally within twenty-four hours.

Dr. Blachstein, in collaboration with Dr. Zunft, succeeded in obtaining from the water supply of St. Petersburg a bacterium which by itself was quite innocuous, but which mixed with the comma bacillus caused the death of animals. A mixture of comma bacillus with the bacterium coli commune obtained from the contents of the intestines of a cow, killed pigeons. The comma bacillus grows very well in a pure culture of bacterium coli, and in growing dis-

places the latter so effectually that within a week no trace whatever of it remains.

With regard to the other mixed cultures, it was found that the comma bacillus entirely disappears in a culture of bacterium caspicum, and within thirty-six to forty-eight hours; on the other hand, transferred into a culture of bacterium beta primus, it first develops abundantly, but soon stops in its development, and after two to three days disappears, and leaves the place to its companion. A growth of the inoculated comma bacillus in the bodies of animals was not observed by them; on one occasion only, Blachstein and Zunft succeeded in recovering the cholera bacillus from the place of inoculation.

In Professor Nencki's opinion, too much attention can not be given to the question of mixed infection in studying the microbiological aspect of cholera etiology. He thinks it clear that other bacteria in some way or the other increase the virulence of the comma bacillus. Nencki believes that if Pettenkofer and Emmerich, instead of drinking a pure culture of comma bacilli, had taken one of the mixtures mentioned above, they would not have escaped with so light a form of cholera.

A very interesting portion of our subject, is the study of the noxa that appear in connection with the processes that belong to the growth and development of the cholera spirilli. Brieger has succeeded in isolating several toxic ptomaines from cultures of the cholera bacillus, some of which had previously been obtained from other sources—cadaverin, putrescin, creatinin, methyl-guanidin. In addition to

these he obtained two toxic substances not previously known. One of these is a diamin, resembling trimethylenediamin; it gave rise to cramps and muscular tremor in inoculated animals. The other poison reduced the frequency of the heart's action and the temperature of the body in the animals subjected to experiment. In more recent researches made by Brieger and Fraenkel, a toxalbumin was obtained from cholera cultures, which, when injected subcutaneously into guinea-pigs, caused their death in two or three days, but had no effect on rabbits.

Pfeiffer finds that recent aërobic cultures of the cholera spirillum contain a specific toxic substance which is fatal to guinea-pigs in extremely small doses. This substance holds a most intimate relation to the bacterial cells themselves, and is perhaps an integral part of the same. The spirilla may be killed by chloroform, thymol, or by desiccation without apparently injuring the toxicity of this substance. It is destroyed however, by absolute alcohol, by concentrated solutions of neutral salts, and by the boiling temperature, and secondary poisonous products are formed which have a similar physiological action, but are from ten to twenty times less potent. Similar toxic materials were obtained by Pfeiffer from cultures of Finkler-Prior's spirillum, and from the spirillum Metschnikovi. From France comes the description of two dangerous toxines; the one considered as a neucleine, the other as a neucleo-albuminine, but which are probably identical with the toxines already described. Cadaverin was thoroughly

studied in 1886 by Brieger, and later on by Kobert of Dorpat. These authors agree on its action as that of one of the most powerful central poisons.

With cadaverin-injections, Behring succeeded in producing symptoms in mammalia, identical with those of Asiatic cholera. This powerful product of bacterial life is described as a most prominent cause of symptoms in the disease. The irritation in the bowel is ascribed mostly to this ptomaine; and when the epithelial destruction is started and the osmotic disorder breaks out, great amounts of cadaverin seem to be taken up in the blood.

Once introduced into the circulation, it is able to attack the very finest and most important parts of the system: the vaso-motor and respiratory centres, the ganglia of the heart, the centre of the temperature mechanism, and the kidneys. According to Brieger and Bocklisch, this alkaloid is composed of $C_{11}H_{11}N_{20}$. Being thus isomeric with saprine and neuridine, it is a diamine, and makes its appearance in animal putrefaction after the disappearance of choline. Patients with cystinuria produce cadaverin by the kidneys. It is also produced by micro-organisms other than the cholera spirillum. Scheuerlen and Grawitz found by experimental observation: *a*. That it produces suppuration (denied by Kobert); *b*. That it interferes with blood coagulation; *c*. That it acts deleteriously on other bacilli; *d*. That it poisons homoiothermal animals. According to Behring: *a*. It decreases the bodily temperature; *b*. Produces death under tonic spasms, paralyzing the respiratory centre; *c*. Produces desquamation of the epithelium

of the bowel-mucosa, with gathering of rice-water-like fluids in the cavity of the gut; *d.* Causes extravasations in several organs.

Later on, Kobert experimented with the muriate of cadaverin on various animals, with the result that this salt may be considered as a very mild poison, if any poison at all. The same may be said of other salts of the alkaloid; for instance, the tannate, lactate, and citrate. I ask you now to make a mental note of these statements as shortly, when we come to study treatment, we shall find them of interest.

The spirillum is not found in the blood or in the various organs or other tissues of individuals who have succumbed to the disease; but it is constantly found in the alvine discharges during life, and in the contents of the intestine examined immediately after death; frequently in almost a pure culture in the colorless "rice-water" discharges. It is evident, therefore, that if we accept it as the exciting etiological factor in producing the disease, the general systemic morbid phenomena must be ascribed to the absorption of toxic substances formed during its multiplication in the bowel-tube. We have already studied various toxic substances, produced in these developmental processes, and have seen what symptoms they produce, in the animal economy. In studying symptomatology, we shall note certain symptoms of cholera, which are identical with those we have seen produced by these toxins. In cases which terminated fatally after a very short illness, Koch found but slight changes in the mucous membrane of the intestine, which was but slightly swollen

and reddened; but in more protracted cases the follicles and Peycrian agmina were reddened around their margins, and an invasion of the mucous membrane by the spirilla was observed, as before shown. They penetrated especially the follicles of Lieberkuhn, and were seen between the epithelial cells and the membrana propria. Rarely is the spirillum present in vomited material, Koch having found it in but two cases, and Nicati and Rietsch in three. In about one hundred cases in which Koch examined the excreta or the contents of the gut of recent cadavers, during his stay in Egypt, in India, and in Toulon, his "comma-bacillus" was invariably found, and these observations were verified last year in Hamburg, but the most satisfactory evidence that this spirillum is able to produce the disease in man was afforded by an accidental infection which occurred in Berlin, in 1884, in the case of a young man who was one of the attendants at the Imperial Board of Health, when cholera cultures were being made for purposes of instruction. Through an accident, the spirillum appears to have been introduced into his intestine, for he suffered a typical attack of cholera, attended by thirst, frequent watery discharges, cramps in the extremities and partial anuria. Fortunately he recovered, but the genuine nature of the attack, was shown by the symptoms, and by the abundant presence of the "comma-bacillus" in the colorless, watery discharges from the bowels.

The experiments of Pettenkofer and Emmerich of Munich and of Hasserlik of Vienna, on their own persons are so recent and so fresh in your memories

that a mention of them on my part will be sufficient. These observers swallowed cholera cultures and subsequently suffered from classical cholera symptoms. Prof. Emmerich's case being the most severe. Pettenkofer took one cubic centimetre of fresh bouillon culture containing living cholera and at the same time to neutralize the acidity of his gastric juice, he swallowed one gramme of sodium bicarbonate. Thirty hours afterwards a diarrhea set in, which lasted eight days and which on the second day was marked by nearly colorless stools. There was no nausea, no change was made in the diet, but there was a good deal of rumbling in the bowels and now and then an imperative call to stool. In Emmerich's experiment the results were more pronounced. There were rice-water discharges and prostration. In both instances the stools contained large numbers of the **specific pathogenic bacilli**.

Finally I would sum up by saying that the spirillum is found in the bowel and the discharges therefrom, in every case of Asiatic cholera, but not always at all times throughout the course of every case. Thus you will often find it difficult or impossible to discover in the later stages of well-marked and even severe cases. Drasche reports its disappearance in fatal cases. On the other hand you will find it to persist in the discharges from the bowels for two and even three weeks after recovery.

LECTURE III.

Resuming our studies of the micro-biology of the comma bacillus, to-day I will call your attention to certain characteristics which are of great interest to us from a practical standpoint, as furnishing us with a scientific basis for measures of prophylaxis, disinfection, etc.

The cholera spirillum grows readily in a great variety of organic media, either in the presence or in the absence of oxygen. In other words it is an aërobic and facultative anaërobic spirillum.

In bouillon the development is rapid and abundant, especially in the incubating oven; the fluid is only slightly clouded, but the spirilla accumulate at the surface, forming a wrinkled membranous layer. Sterilized milk is also a favorable culture medium. In general this micro-organism grows in any liquid containing a small quantity of organic pabulum and having a slightly alkaline reaction. It is however essentially a "protective tariff" bacillus, and can not compete with foreign labor, for in media containing other active micro-organisms, it languishes and loses strength and vitality. An acid reaction of the culture medium prevents its development, as a rule, but it has the power of gradually accommodating itself to the presence of vegetable acids, and grows upon potatoes—in the incubator only—which have a slightly acid reaction. Abundant development occurs in beef-tea which has been diluted with eight or

ten parts of water, and the experiments of Wolffhugel and Riedel show that it also multiplies to some extent in sterilized river and well water, and that it preserves its vitality in such water for several months. According to Kinyoun it may preserve its vitality in sterilized sea-water, taken from New York Bay, for a considerable time, but not for a longer period than sixty days.

In an interesting article on the chemistry of the cholera bacillus, Ferran states that when it is cultivated in a slightly alkaline bouillon, containing lactose, paralactic acid is produced in quantity sufficient to render the liquid distinctly acid. When this microbe is sown upon agar that is slightly alkaline, and containing lactose as well as litmus, the medium becomes red from the formation of paralactic acid. A cultivation in a slightly alkaline bouillon containing lactose presents, after being left at rest at 30° C. (86° F.) for five days, a floating mycoderm, consisting of large comma bacilli, in the interior of which may be seen one or two very small granulations analogous to spores; eventually all the protoplasm of the bacilli disappears, leaving exposed these small granulations which are readily colored by methyl-violet. The same bacillus sown in a small quantity of alkaline bouillon, contained in a capacious flask, may remain alive for more than three years, provided that the flask is closed by cotton wool, which will allow of the renewal of the air. Under the very same conditions, and with the sole difference that the bouillon contains some lactose, the vitality of the microphyte is rapidly extin-

guished by reason of the acid character communicated to the medium by its own action. In ordinary culture bouillons the growth of this microbe is always rapid and luxuriant; but when the bouillon contains lactose it is disproportionately less prolific. The colonies become very numerous in consequence of the addition of that substance, within a few hours; but the growth ceases completely as soon as the medium becomes acid, and before long the vitality of the microbe is destroyed. Ferran calls attention to the resemblances between the chemical function of this microbe and that of the bacillus coli communis. In many particulars their pathogenic functions are also similar. Paralactic acid paralyses the chemical activity of both, a fact to which we will later refer when studying treatment.

In an extended experimental research made by De Giaksa, in 1889, it was found that in sterilized sea-water the cholera spirillum multiplied abundantly for a time, and retained its vitality for a considerable period; but in non-sterilized sea-water it died out within two or three days, the rapidity with which it disappeared being in direct ratio to the number of common saprophytes in the water. It has also been found that it dies out within a few days in milk or in river water, which contains numerous saprophytic bacteria.

Gruber and Schottelius have shown that in bouillon which is greatly diluted the cholera spirilla may take the precedence of the common saprophytic bacteria, and that they form upon the surface of such a medium the characteristic wrinkled film. Koch

found in his early investigations that rapid multiplication may occur upon the surface of moist linen, and also demonstrated the presence of this spirillum in the foul water of a "tank" in India, which was used by the natives for drinking purposes. Macnamara reported the vitiation of certain drinking-water by cholera dejecta, and the production of the disease in individuals using the fluid for drinking purposes, the water having acted as a culture medium. In Bolton's experiments in 1886, the spirillum was found to multiply abundantly in distilled water to which bouillon was added in the proportion of fifteen to twenty-five parts in one thousand.

An interesting question is the ascertaining of the thermal death-point of the spirillum. In recent cultures in flesh-peptone-gelatine, Sternberg found it to be 52° C. (125.6° F.), the time of exposure being four minutes; a few colonies only developed after exposure to a temperature of 50° C. (122° F.) for ten minutes. In Kitasato's experiments in 1889, ten or even fifteen minutes' exposure to a temperature of 55° C. (131° F.) was not always successful in destroying the vitality of the spirillum, although in certain cultures exposure to 50° C. (122° F.) for fifteen minutes was successful. He was not, however, able to find any difference between old and recent cultures as regards resistance to heat or to desiccation. In a moist condition this spirillum retains its vitality for months—as much as nine months in agar and about two months in liquefied gelatine. It is quickly destroyed by desiccation, as first determined by Koch.

who found that it did not grow after two or three hours when dried in a thin film on a glass cover. In Kitasato's experiments in 1889, the duration of vitality was found to vary from a few hours to thirteen days, the difference depending largely upon the thickness of the film. When dried upon silk threads it may retain its vitality for a considerably longer time. Most interesting observations have been made by Dunham of New York, under the direction of Dr. Koch, concerning the viability of the bacillus, and such experiments prove valuable in throwing light upon the way in which cholera may spread from place to place during an epidemic. In agar-agar cultures this observer found that it is possible for the bacillus to retain its viability in a single culture, without transplantation, for six-hundred and eighty-one days; one year, ten months and ten days. He also found that cholera *may* live in agar culture, three hundred and eighteen days, at a temperature closely approximating that of the human body. In fecal matter, four experiments were made, and the mixture examined daily for living cholera bacilli. In no case were they found after the sixth day. The difficulty of finding the bacillus in such a mixture increases with the age of the mixture, so that the failure to find them on a given day can not be taken as proof that there were none present. When, however, as in these cases, a rapid diminution in the number present in equal bulks of the mixture examined from day to day is observed, and afterward, for a number of successive days, none can be found, the presumption seems reasonable that the bacillus

gradually dies out and is no longer present in a living state, soon after all efforts to detect it, fail. Dunham experimented with, among other materials, urine, dirty water and sewage. In the latter he found that a sample of neutral reaction collected at the Berlin city pumping station, inoculated with cholera from agar and kept at the room temperature, contained living cholera bacilli after twenty-four hours, but after forty-eight hours none could be detected nor could any be found on the first, third, and sixth day thereafter.

In river water, nine experiments were made in which water from the Spree was inoculated with cholera bacilli and then examined from day to day to determine the presence and number of cholera bacilli in known quantities of the water. The water was not sterilized before the cholera was added to it, and the conditions of the experiment were varied with respect to the access of air, agitation, and addition of fresh water from the river. For details of the experiments, I must refer you to Professor Dunham's original article, suffice it now to say, that in no case could living cholera bacilli be found after the sixth day. These results must, of course, be taken with the same allowance as those derived from the experiments with fecal matter. Of the experiments on textile fabrics, I will quote two: A piece of flannel was soaked in blood-serum mixed with cholera from an agar culture, and kept in a lightly covered glass dish at the room temperature. Examined almost daily, by means of plate culture, or sixteen days. Living cholera found up to and

including the ninth day; after which a contamination with rapidly liquefying bacteria rendered the examinations negative. In another, a piece of old sheeting was used. This was soaked in soapy water, and after having been dried, was dipped in bouillon containing cholera from an agar culture. Part of the cloth was kept in a loosely covered glass dish. In this, living cholera was found after forty-eight hours, but none on the sixth or seventh days. Other portions of the cloth were rapidly dried in the air, and on these no cholera was found after forty-eight hours, and seventy-two hours. A very large number of observations were made in connection with fruits and vegetables, such as cauliflower, cucumber, strawberry, onion, tomato, grape, peach and cabbage, and they go to show, that while most of these substances can not be regarded as media suitable for the indefinite maintenance of the life of the bacillus, they are not so unfavorable to its existence that they might not readily serve as vehicles for the distribution of the germ. It appears that the most destructive influence is exerted by other bacteria, which take possession of the substratum to the exclusion of the cholera bacillus. But by the time this has taken place such substances as are articles of food would no longer be regarded as fit for consumption.

Very many experiments have been made to determine the amount of various disinfecting agents required to destroy the vitality of this micro-organism. I quote for you here the results of Boer's observations, made in Koch's laboratory, on a culture in bouillon kept in the incubating oven, for twenty-four

hours, time of exposure, two hours:—hydrocyanic acid, 1 to 1350; sulphuric acid, 1 to 1300; caustic soda, 1 to 150; ammonia 1 to 350; mercuric cyanide, 1 to 60,000; gold and sodium chloride, 1 to 1000; silver nitrate, 1 to 4000; arseniate of soda, 1 to 400; carbolic acid, 1 to 400; lysol, 1 to 500. In Bolton's experiments, mercuric chloride was effective in two hours in the proportion of 1 to 10,000; cupric sulphate, 1 to 500.

The low thermal death-point and comparatively slight resisting power for desiccation and chemical agents, indicate that this spirillum does not form spores, and most bacteriologists agree that this is the case. Hueppe, however reports a mode of spore formation which is different from that which occurs among the bacilli, to-wit: the formation of so-called arthrospores; these are said to be developed in the course of the spiral threads, not as endogenous refractive spores, but as spherical bodies which have a somewhat greater diameter than the filament and are somewhat more refractive. Hueppe describes a splitting up of vegetative cells into small fragments, which become rounded like spores, and when transplanted grow into spirilla. This mode of spore formation has not been observed by Kitasato and other bacteriologists who have given attention to the subject, and can not be considered as established. In competition with the ordinary putrefactive bacteria the cholera spirillum soon disappears, and Neffelman and Kitasato have determined, what we have already noticed by Dunham's experiments, that they only survive for a few days when mixed with normal feces.

The cholera spirillum grows best at a temperature of 30° to 35° C. (86° to 95° F.) and ceases to grow at a temperature above 42° C. (107.6° F.), or below 14° C. (57.2° F.) Like other micro-organisms of this class, it is not destroyed by a freezing temperature. Your attention is called to this fact, for it is extremely valuable from a practical point of view, as many times drinking water that had been rendered pure (or being previously pure) has been inoculated by vitiated ice, which melting in the water, has set free living cholera.

For various reasons, obvious without detailed explanation, you must be able to differentiate between true cholera, and the local form; again there will be occasions when it will be necessary for you to determine as to the existence or non-existence in fluids, in perhaps dejecta material, or on clothing, of the cholera germ. This you can not do, unless you are familiar with the physical characteristics and habits of the comma-bacillus. My esteemed friend and learned colleague, Professor Adolph Gehrman, has furnished me with a very clear and explicit set of rules for this operation, which I now tabulate for your information:

GEHRMAN'S RULES FOR THE DEMONSTRATION OF THE
CHOLERA SPIRILLUM.

We have to consider:

- a. *The collection of the material.*
- b. *The preservation and transport of the material.*
- c. *The examination of the material.*
- d. *The differentiation of the spirillum.*

a. The cholera spirillum may be demonstrated in the feces, vomit, or in the intestinal contents of cholera suspects. Only fluid feces or vomit should be investigated. The material is best collected in a vessel that has been thoroughly scalded with boiling water, from which it is poured into flasks or morphine bottles, that have been sterilized by dry heat at 160° C. (288° F.), for one hour. After the bottles have been filled and closed they must be washed in a one to one-thousand solution of mercury bichloride, to avoid accidental infection of persons during transportation to the laboratory. When the intestinal contents are desired, it is best to make a small opening into the intestine and allow the material to flow directly into the bottle.

b. The material should always be examined as quickly as possible, as cholera soon loses its vitality when in contact with actively growing saprophytes. The bottles should therefore be packed in ice and taken to the laboratory. When it is necessary to use the mails, the greatest care must be taken. Only strong, tightly corked bottles must be used, these are to be packed in regulation mailing cases with sufficient absorbent cotton to absorb all of the contained fluid. If the mailing case is then in turn, packed in a tin or metal case or can, it may be sent without danger. When the laboratory is more than twenty-four hours distant, pieces of thin cloth should be saturated with the material and dried at a temperature not exceeding 45° C. (113° F.) These are placed in bottles and packed as before.

c. In the laboratory the bottles are again washed

in bichloride solution and then opened. The contents are examined as follows: A number of test tubes are prepared, each containing fifty per cent. beef bouillon which has been diluted with eight or ten volumes of sterilized water. Ten per cent. nutrient gelatine is also ready, and this must have a reaction that is positively alkaline. In these are the best conditions for growth; in dilute bouillon they grow much more rapidly than the accompanying saprophytes, especially at 37° C. (98.6° F.), and in the gelatine they are favored by the alkaline reaction. The bouillon tubes are inoculated with the straight inoculating rod and placed in the incubator. At the same time, several plate cultures are made on gelatine in Petri dishes. Lastly slides are prepared from the fluid remaining. At the end of twenty-four hours, the cultures are examined. If there is any growth at all, upon the surface of the bouillon, other tubes are immediately inoculated from it. The fluid is also examined microscopically for characteristic organisms. The plate cultures will show, at the end of twenty-four hours numerous whitish colonies, that liquefy the gelatine. From these, bouillon and plate cultures and slides are prepared. This must be continued until some definite characters either for or against the presence of cholera, are observed. When cultures presumably cholera are obtained they must be differentiated.

d. In the bouillon tubes, at 37° C. (98.6° F.), cholera grows quickly, producing a film upon the surface. From this, pure cultures may sometimes be obtained. In addition the indol reaction should be

tried upon the bouillon cultures. This consists in the addition of a small quantity (five drops) of pure sulphuric acid, when, in several hours a reddish violet or purplish color will develop. If litmus blue, sufficient to color, is added it will be decolorized at incubator temperature, which does not occur with allied organisms. Upon the gelatine plate cholera appears at first as small white granular colonies, and the gelatine is liquefied in funnel form. The indol reaction may be tried here. In the gelatine test tube it liquefies just below the surface, below which the inoculation streak remains finely granular for some time. Later the gelatine is entirely liquefied and the usual film is seen upon the surface. Upon agar-agar it produces a whitish smooth film. The growth upon potatoes is not characteristic. Under the microscope it appears, in the hanging drop, as a small bacillus or spirillum, having an extremely active motion. Long spirils are seen at times. Cover glass preparations may be stained with any stain.

When soiled linen or cloth saturated with material, is examined the same method is used. The cloth is moistened with water and scrapings from the surface are used to inoculate diluted bouillon. From these, gelatine plate cultures and slides are made.

I have tabulated on the board, the following simple rules for your guidance, in testing for the *spirillum cholerae Asiaticæ*.

In making the test, you will require the following articles: *a*. One microscope with Abbe's condenser; *b*. A solution composed of fifteen grains of fuchsin in three ounces of water plus two-and-a-half drachms

of alcohol; *c*. Some pipettes, a couple of glass rods and object and cover glasses; *d*. A couple of glass rods with a piece of platinum wire soldered in one end; *e*. Several hollow slides; *f*. About a dozen glass plates about five or six inches by three or four inches in size; *g*. About a dozen ordinary glass plates; *h*. An alcohol lamp or Bunsen burner; *i*. Test tubes with sterilized gelatine; *j*. Test tubes with sterilized nutrient bouillon; *k*. Two Erlanger's glasses one-third filled with a solution made as follows: Fifteen grains of peptone, seven-and-a-half grains of sodium chloride, in three ounces of water; *l*. Some concentrated sulphuric acid.

We will suppose now that you desire to examine some material from a rice-water stool of a cholera-suspect. Scatter a little of the dejection matter on a glass plate, in a thin film, and with a platinum loop isolate some flaky material on the edge of the plate. From this take a piece the size of a pin head and with a sterilized platinum wire loop evenly divide it by rubbing on a cover glass. Remove all superfluous matter by pressure with another cover glass, and let it get air dry. Now draw it three times through the flame of your alcohol lamp or Bunsen burner (as in tubercle-bacillus preparation) and with a pipette, add a few drops of the fuchsin solution. Then wash with distilled water, add a couple of drops of water to the cover glass and lay it on a slide. Examine with oil-immersion system. To make a permanent preparation, after staining, wash off all excess of stain, let it get air dry and mount in Canada balsam.

Where the stool is bloody and dysenteric in char-

acter, it is best at once to proceed to culture making. Take a hollow slide and along the border run a thin edge of vaseline. Then with a platinum loop bring a drop of sterilized bouillon into the hollow groove and inoculate it with a little of the suspected material. Lay a cover glass on so that its rim rests on the vaseline edge, and set the whole aside in a temperature of from 22° to 23° C. (71.6° to 73.4° F.) In twenty-four hours the bouillon becomes turbid and the slide can then be examined under the microscope by the oil-immersion system. Examine along the border-line.

Schottelius' method is as follows: Take about three ounces of the stool-matter and put it in a beaker glass with about eight ounces of meat bouillon of a mild alkaline reaction. Let the mixture stand for from twelve to twenty-four hours at a temperature of from 30° to 40° C. (86° to 104° F.) At the end of the time mentioned, cholera spirilla will be found in the upper layer. In this layer introduce your wire loop, draw out a drop and prepare it for examination in the hollow slide as just described.

In the necropsy hall in making a post-mortem examination, open the abdominal cavity and isolate a piece of the ileum about two or three inches in length near the cecum, with four stout twine ligatures, as shown in figure.



After the ligatures have been tied, then with knife or scissors, cut through the gut at the points indicated in the diagram by the dotted lines, and remove the separated piece. In the same way take away a piece from the upper part of the ileum. Handle the intestine very gently, so as not to empty of its contents, the section you desire to remove. By leaving tied the cut ends of the tube remaining in the body, you prevent the contents of the bowels being emptied into the peritoneal cavity, which is a desideratum. Now you can treat the more or less fluid matter you will find in the isolated sections of the gut, by the modes just described. Make sections of the gut-wall parallel to its surface, and examine them under the microscope, paying especial attention to the epithelial structures.

Make potato cultures, stroke and stick gelatine cultures, and cultures in blood-serum and agar-agar.

LECTURE IV.

Having thoroughly studied the microbiology of the specific exciting etiological factor of Asiatic cholera, and learned how to seek for and recognize it; we find the following question facing us for solution: Under what circumstances and through what channel do the comma bacilli penetrate into the human system, and in what manner do they there excite the characteristic processes of the disease? There can be no manner of doubt whatever but that here in America the disease is not indigenous, but is always imported. It is not an air-traveler, but as we have seen, follows the lines of human traffic, progressing along the world's most frequented highways, with a rate of speed that is in direct ratio with that afforded by the means of human intercommunication. We are equally certain that the main, if not the only agent for the spread of the malady is the dejection material from cholera patients, which we find to be rich in cholera spirilla. In this connection we must also consider the pathogenic value of vomited matters. These bacilli escaping from the interior of the body, into the external world, find abundant means to prolong their life and existence, exemplifying the words found in Holy Writ, "That it is that which cometh out of a man which defileth a man." They grow and develop upon moistened bed-clothing, or in water, or in food, either solid or fluid, or in moist earth. Of course, in order that the disease

may be induced in a given individual, conditions favorable to the reception, growth and multiplication of the bacillus, must exist. These conditions are known as contributory causes, or predisposing factors, and when they are propitious, and the exciting factor is present, the disease is produced. In relation to its growing and living in moist earth I would call your attention to a very interesting characteristic of the spirillum, and that is its nitrifying power. Franklin, in England, and Wynogradsky, in France have recently described certain minute bacilli or cocci which are found in the soil, and which possess the power of oxidizing ammonia to nitrites. These nitrifying bacilli play an important part in rendering the soil fit for the growth of plants, and the possession of this power by the comma-bacillus may be regarded as an indication of its fitness to live in the soil, and thus lead to a non-parasitic mode of existence. Let us look now at the modes of infection. It would seem as if cholera is not highly contagious in the same sense as variola and scarlet fever, but resembles enteric fever, in this respect. The impression that physicians, nurses and others in close contact with the patients, are not often affected, did not prove to be correct in the epidemic last year at Hamburg, where the medical attendants and nurses suffered quite severely. It is reported that of the fifty doctors who went to that city to assist in the work there, hardly one escaped a more or less severe choleraic attack. It is easy to understand why certain persons, as washer-women, laundresses and nurses, are more liable to infection than others, and

the spread of the disease, is often explained by certain outward circumstances.

The consensus of opinion on the part of the leading authorities, is that the disease is propagated chiefly, if not entirely, by the contamination of water used for drinking, washing and cooking. It is easy to believe that contaminated food may prove a factor in this connection, but to a lesser degree than drinking water. We have seen that the bacilli can and do develop in water-supply reservoirs, as tanks, etc., and Osler's pithy expression, that the virulence of an epidemic in any region is generally in direct proportion to the imperfection of the water-supply, expresses volumes. So emphatic is this statement in its truth, that we cannot devote too much labor and attention to our water-supplies. It has been proven time and time again, by the fact that where there have been improvements and perfection in the water-works of a locality, the epidemics have been reduced in intensity, and immunity even has been obtained. You remember in studying the etiology of enteric fever, we found Pettenkofer placing great value on the condition of the ground-soil, and in cholera transmission we find him denying the truth of the drinking water theory, and maintaining the importance of the conditions of the soil, especially as regards porosity, moisture and contamination with organic matter. This authority claims that the germs develop in the sub-soil moisture during the warm months, and that they rise into the atmosphere as a miasm. To assume the absolute correctness of Pettenkofer's theory, and to deny the possibility of

infection in any other way, would be to accept a statement entirely at variance with many observed facts, and one that is not borne out by the characteristics of many studied epidemics and outbreaks of the disease.

Cholera is more liable to occur in places at the sea level, than in those situated inland, and does not prevail so extensively in high altitudes. A high temperature favors the development of the disease, but in our country and in Europe, the epidemics usually take place in the late Summer and Autumn.

It is no respecter of person, age or sex, but is particularly prone to attack those in whom for any reason whatever, the normal powers of resistance are lowered. Reducing psychical emotions, as fear and anxiety, beyond a doubt have a most marked influence. It is very doubtful whether one attack confers immunity from a second. In an interesting manner Dr. Alexander, quoting Hough, Richardson, Neusville, Billings and others has discussed the causes that partially exempt Jews as a race from cholera and other epidemics.

In order that the disease should be produced, the spirilla must gain access to the alimentary canal, must reach the mouth, pharynx, gullet, etc., before they can start on their career. The comma-bacillus is never found in the human economy except in the digestive tube, never in the blood, never in the glandular system, nor in the secretions—only in the bowels, and what they contain. It is not at all an easy matter for the bacillus to reach the bowels belonging to a healthy person provided with a good diges-

tion. A healthy stomach has the best safe-guard against it, in the free acid of the gastric juice. We have seen that small traces of acid will interfere with the life of the bacilli, and the normal stomach secretion is acid enough to kill them, should they remain even for a short time in the functioning organ. But we know that the resting stomach does not contain any of this juice, and we also know from the experiments of Kuehne, Richet, Beaumont and Ewald, that fluids can pass the pylorus within a few minutes; and if a large amount of water, for instance, is swallowed at once, part of it will pass the pyloric junction the very next minute. It has also been shown that draughts of water taken into the stomach do not excite its functional activity, but uncontaminated by gastric secretion, pass into the duodenum.*

In such a case even the healthiest man could get some germs unhurt into the bowels; and that is all that is needed, to have the disease developed in perhaps a few hours.

It is stated that the period of incubation, is from one to three days, but there is no doubt in my mind but that it may be shorter than even one day.

We can easily understand why it is that dyspeptics, or those in whom the gastric function is below par, are liable to suffer. Beaumont has shown that a decrease of acidity of the stomach secretion is the

*I have repeatedly verified Ewald's observation in this respect, on my own person, both by drinking large quantities of water, at various periods of time emptying the stomach by a syphon tube or by inducing emesis mechanically; and by swallowing small pieces of clean sponge to which were attached strings of surgical silk, by which, after they had been allowed for varying periods of time to remain in the stomach, they would be pulled up. The reaction of all being carefully tested before and after exposure in the stomach.

result of febrile disturbance. Manassein and Hoppe-Seyler have demonstrated that such a gastric juice is weak and deficient in action; and Beaumont's observations indicate that acute or chronic disturbances of the gastric glandular apparatus, partly or fully interfere with the production of a normal succus gastricus. In these cases it is the lack of acid that is the cause of trouble.

Let me call your attention to the emotional factor in etiology. The secretion of gastric juice is much influenced by nervous conditions. It was noticed by Dr. Beaumont, in his observations upon Alexis St. Martin, that irritation of the temper or other moral causes would diminish or suspend the supply of the gastric fluids. Any febrile action or unusual fatigue would exert a similar effect. Every one is aware how readily mental disturbances, such as anxiety, fear, anger or vexation, will take away the appetite and interfere with digestion. Impressions of this kind, especially at the commencement of the process, seem liable to produce a lasting effect and to disturb digestion for the entire day. In order, therefore, that the function may be properly performed, food should be taken when the appetite demands it; it should be thoroughly masticated, as a wise man of our time has said, there being thirty-two teeth in the head, each mouthful should be chewed thirty-two times; and, finally, both mind and body should be free from unusual or disagreeable excitement.

Were it not for this protective acid gastric solution, on the first tour of Asiatic cholera, it would have almost depopulated the globe.

Let us now see what would be the result, should any of these bacilli pass unchallenged through the pylorus, and enter the cavity of the duodenum.

It has been noticed by us that a fluid of alkaline reaction highly favors the vitality and action of the comma-bacillus; moreover that the bodily temperature is the best for its development. Consequently, a better soil than the intestinal fluids could not be found for their growth; and they will at once begin to develop their immense fecundity, and multiply with a rapidity that startles human comprehension.

The first sign of their existence in the bowel, anatomically, seems to be an increased flow to the vascular parts of the gut-wall, due to irritation. Very soon the signs of catarrhal inflammation develop; the solitary follicles and Peyerian patches begin to swell and become peripherally congested. All the intestinal glands increase their work, and soon a slippery layer of tough and glassy mucous covers the epithelium all over. Hemorrhagic spots appear in the submucous strata. The slender delicate epithelial cells cannot any longer bear the enormous over-irritation; they begin to stagger, loosen their foothold, and become swept away from large surfaces. Soon the interior of the intestine becomes filled with an abundant transudation, the gut-coils containing a large amount of clear fluid, resembling gruel or rice-water, and so devoid of biliary matters as to indicate the suspension of hepatic activity. This fluid consists of the results of hyper-secretion of the glands of the small intestine, and plasma-sanguinis, alkaline and blood-warm, from the interior of the vessels,

forming a culture medium in the highest degree favorable for the multiplication of the spirilla. As time goes on the signs of inflammation of the mucous membrane become more pronounced. The processes already noticed in the patches and follicles advance, the epithelial desquamation becomes more extensive, and later on the intestinal trouble frequently assumes a croupous-diphtheritic character. The surface becomes necrosed and ulcerated in many places, and the contents change from the rice-water containing immense numbers of cholera spirilla, to a bloody, foul-smelling liquid containing fewer cholera germs but large numbers of other morbid micro-organisms. According to Cohnheim, the fluid found in the gut-cavity, is not due to transudation from the blood vessels at all, but is entirely caused by an extraordinary profuse secretion from the intestinal glands; while others place the source as being from the circulatory apparatus. In all probability both factors are potent in the affair.

Let us look at this condition closely for a moment; the bowel, being deprived of its osmotic regulators, and having lost the lymphatic aids in the follicles and agminate glands, will soon become over-filled. The choleraic poison stimulating to hyper-activity the glandular mechanism in the gut-wall, and liquor sanguinis freely passing into the bore of the tube, on account of the blocking of the lymphatic channels, over-distension must occur unless the bowel can relieve itself by catharsis. In sudden cases, where the individual has been quickly overpowered by the intense virulence of the poison, death will take place

without there having been a single passage or stool. In these instances the intestinal tube will be found enormously distended, with the contained fluid.

So far we have studied the process entirely from a local standpoint, but soon after the beginning of the development of the bacilli, we find that there is a general or systemic element that is pronounced and prominent. Closely connected with the vital processes of the spirilla there is the creation of the toxins which we have touched upon in our consideration of micro-biological chemistry. These toxins are very soluble and highly diffusible. They pass into the life stream of the blood and circulating through the vessels with it, they produce general or constitutional and special local symptoms, whose degree is in direct ratio to the amount and intensity of the absorbed noxa. From our knowledge of the physiology of the digestive tube, and from our acquaintance with the cholera spirillum, we are prepared for the recognition of the fact that the growth of the comma bacillus, is limited as far as time is concerned, in the intestinal cavity. We know that the cholera germ will not thrive in media wherein other micro-organisms are growing or living. Now in the bowel of the healthy, normal man, there are going on processes, which are to be regarded as fermentations or putrefactions, and which are quite different from those caused by the digestive enzymes or ferments. These putrefactive changes are connected with the presence of low organisms, the fermentation or putrefaction-producers; and they may develop as you know, in suitable media outside of the body.

They are wanting during fetal life, but are numerous a few days after birth. They have been found in the saliva, stomach and intestine. From the normal intestinal mucus Babes has isolated five species of bacteria, while an enormous number of micro-organisms exist in the large intestine and feces, Vignal calculating their number at twenty millions per decigram of feces. The activities of these, and of other forms that following closely upon the comma bacillus, gain entrance to the system by treading in its footsteps, ultimately interfere with cholera growth.

On post-mortem examination, you will find the appearances that are associated with profound collapse. There is often well-marked post-mortem elevation of temperature. Rigor mortis sets in early, is pronounced and disappears late, being an exception to the general rule that when it occurs soon after death it disappears quickly, and when its onset is late, its disappearance is deferred. Post-mortem movements of the various portions of the body are noticed after death by cholera. Displacements of the body, movement of the lower jaw, rotation of the eyes, and changes of position of the arms and legs have been described. Dr. Edward Vanderpoel, of New York, in an interesting communication to the *Medical Record*, last fall, describing the epidemic of 1832, says that it was a common thing for those who died during the day and who were put in a coffin at night, to be found the next morning with their arms out of the coffin, or their hands up to their heads.*

* Professor Eichhorst also relates that on one occasion he had left a patient for dead, when, three hours later he was told that the dead man had revived.

All the internal organs are dry, pale and anemic. The left ventricle is usually contracted, and the blood lies mostly in the great veins, the right heart, and the cerebral sinuses. It is thickened, dark-colored, but little clotted, and there is a remarkable diminution in the amount of water and salts. The peritoneum is sticky, and the coils of intestine are congested and look thin and shrunken. The spleen is usually small—an exception to the rule in infectious diseases. The kidneys present marked passive congestion, and if the subject has suffered for any length of time from the disease, may show cloudy swelling, a greater or lesser degree of parenchymatous nephritis, and destruction of the epithelium. Cloudy swelling of the hepatic cells, or more pronounced changes, depending upon the length of time the individual had lived with the disease, are noticed. The lungs are collapsed, and congested at their bases. When death takes place late, or at an advanced stage of the malady, the tissues have lost their characteristic dryness, and the most diverse local lesions, may be found to have caused death. In these advanced cases the condition of the small intestine, will often be found to simulate very closely that of the small intestine of an individual dying in the third week of enteric fever.

To recapitulate, I would call attention to Van

He found that the muscles of the upper arm were giving short, quick motions, following each other rapidly, which were interrupted by contractions of the whole group of muscles, whereby the forearm was visibly contracted. The fingers were also distinctly observed to be moving, as though playing a piano. It was only after three hours that the movement of the muscles stopped.

Cott's excellent *résumé* of the pathological findings in cholera.

R. Pfeiffer has shown that the specific toxine of cholera is a ptomaine which is probably incapable of complete isolation from the germ, without losing much of its toxic force. He believes that either the ptomaine is in intimate atomic association with the actual protoplasmic atoms of the germ, or that the protoplasm of the germ itself is a rank intoxicant. In any event, dead bacilli in sufficient quantities produce the characteristic semiology of cholera.

Subcutaneous injections of the cholera virus are far less toxic in animals than intra-peritoneal injections. Both are followed by marked fall of temperature, great prostration, muscular spasm and cramps.

Transplantations and successive cultivations, weaken the potency of the spirilla.

Koch showed in 1884 that the intestine and stools were loaded down with his bacillus.

Nicati and Ritsch found the germ in the follicles of Lieberkuhn, and positively assert that it obtains in the intestinal wall, (supposedly the mucosa and sub-mucosa). They also succeeded in inducing cholera at once in animals, by injecting pure cultures of the comma bacillus into the intestine, after ligature of the ductus communis choledochos.

According to Eisenberg, no cholera germs have been determined in the blood of human cholera patients.

These data simplify the pathology of cholera. Local intestinal irritation, with doubtless general intoxication through absorption of a toxine into both the

blood and lymph, are productive of profound constitutional and local symptoms, thermal depression, nervous phenomena, profuse diarrhea. In general the serous surfaces are dull, and often covered with a gluey deposit. The blood is anhydremic, dark-colored, thick, tarry and coagulates imperfectly.

Rigor mortis occurs early and lasts unusually long. The arteries are empty, the veins generally filled, while the heart may be either full or empty. Sometimes the left ventricle is found contracted, at other times the whole heart is found quite flabby. There is great general emaciation. The Peyerian patches are, reddened, slightly swollen, and sometimes necrotic. Complete epithelial desquamation from the intestine occurs, to some extent post-mortem, and there is sometimes intestinal hemorrhage.

In the kidneys, the cortex is usually found swollen and pale; and the medulla congested on the venous side. Anuria probably due to water abstraction. The spleen and liver are not markedly affected, although the liver is changed in protracted cases. The brain and cord are said to be much firmer than normal. Bartholow describes a congested state of the bulb, which bears relation to the intensity of certain of the symptoms; noticeably the muscular cramps. These are the findings in death during the algid stage.

The reactionary stage presents lesions of inflammatory and hemorrhagic nature. Hemorrhages, usually petechial, may be exceedingly numerous, or profuse hemorrhage may obtain. Meningitis and peritonitis may supervene.

The exact reason for the development of the hemorrhagic and inflammatory tendencies is not stated; probably the toxic action of the poison on the vessels predisposes to their rupture, especially the smaller ones. Analysis of stools reveals large quantities of blood serum, myriads of epithelial cells and leucocytes, and abundant supply of the specific organism. These ingredients explain the color and other gross appearances of the dejecta.

To sum up, there is rapid emaciation from loss of water, which is held by some to account for the muscular cramps, which are so distressing a symptom. Hyperemesis and hypercatharsis due to local irritation and to central excitation. We can conceive of the poisoned blood irritating the nuclei in the floor of the fourth ventricle, and producing excessive vomiting. Cyanosis due to the disturbance of the physiological equilibrium of the blood, and to nervous and cardiac depression. The hemorrhage and inflammatory tendency in the reaction stage, are not definitely explained.

LECTURE V.

Together you and I have studied the causative factors of cholera; together we have been taught how to search for and how to recognize the comma-bacillus; together we have gone down into the charnel house and looked at the dead; we have opened the body and examined the morbid changes produced by the disease; but to-day, I ask you to accompany me to the bedside and watch the sick man, and we will now take up the study of symptomatology, and gaze at the clinical picture.

As in nearly all the infectious diseases, so in cholera, the intensity of the illness varies between the extremes of mildness and severity, so that in a great number of cases a correct diagnosis of the mildest forms, can only be made, by the fact of the existence of an epidemic. These simple cases are called "choleraic diarrhea," and resemble in a marked manner, cases of ordinary summer-cholera. The symptoms are those belonging to an attack of violent, acute catarrhal enteritis; during the twenty-four hours, there are from three to ten large, watery and usually painless stools. There is loss of appetite, more or less thirst, and general malaise, some times even now there may appear choleraic symptoms, such as vomiting, pains in the calves of the legs and diminution in the amount of urine voided. Many cases recover after a few days, but in others, after from one to three days, there comes on a severe attack of cholera.

In gradual transition, these mild forms, are succeeded by more pronounced ones, which are called "cholérine." Cholérine comes on very much like a sudden and severe attack of cholera-morbus, often beginning at night. There may be a severe diarrhœa, which may assume the characteristics quite early of pronounced cholera. Vomiting soon comes on, and there are more or less violent constitutional symptoms. We find languor and depression, the voice becomes weak, the extremities cold, the heart's action is hurried and feeble the pulse being quick and small, muscular spasms and painful cramps occur in the bellies of the gastrocnemii, the urine becomes decreased in amount, and examination perhaps reveals the presence of albumen. The whole attack may last a week or two, until recovery be complete, but the course is not infrequently varied by repeated improvements and relapses. From these cases of medium intensity, we find gradations until we reach the severe forms of cholera proper. In the most intense form, "cholera-foudroyant," the patient may be stricken down, and die overcome by the virulence of the poison, in a few hours without having had a single stool.

Ordinarily three stages may be recognized in the attack, which is preceded by a period of incubation of uncertain length, but which is probably from one to three (or perhaps four) days in duration.

The stages referred to, are: the preliminary diarrhœa, the algid stage, and the period of reaction.

A true attack of cholera may begin very suddenly, and without any preliminary diarrhœa, but with

severe symptoms. As a rule, however, the first stage appears, and after from one to three days, is replaced quickly and suddenly by the pronounced symptoms of the algid stage, or cholera asphyxia. This stage is ushered in with abrupt bodily weakness, chilliness, and vertigo. Shortly after, the gastro-intestinal symptoms declare themselves. The diarrhea becomes distressing. At short intervals, the patient has copious painless dejections, at first of a feculent, bilious character, but soon changing, present the appearance of the "rice-water" or "gruel-whey" fluid, or the rice-water characteristic may be prominent from the beginning. A single stool will measure about a half a pint, or two hundred grams. The stools are colorless and odorless. They are watery, alkaline, or neutral in reaction, and on standing usually deposit a finely granular, grayish-white sediment. Examination shows the following composition: about one or two per cent. is solid matter, with a small amount of albumen and a large quantity of sodium chloride. In severe cases, and especially in the later stages of the disease, there is more or less blood, or saigneous matter. Under the microscope we find epithelial cells, triple-phosphate, and numerous micro-organisms, consisting of the comma-bacillus, and bacteria of putrefaction. Of a certainty as soon as the cholera spirillum is demonstrated, the diagnosis is absolute. I have already shown you how to find the exciting causative factor of cholera, which you must always look for, if there is any element of doubt as regards diagnosis, unless it be during an epidemic, when I think it to be

perfectly correct to treat every case of diarrhea as the first stage of a cholera attack.

These excessive evacuations are almost pathognomonic of the disease, but there are cases in which death will occur without their having been present, these are cases of "cholera-sicca," or dry cholera.

Soon after the onset of the diarrhea, there is frequent vomiting, which rarely though becomes distressing. Sometimes late in the disease, the vomiting becomes "projectile," such as is found connected with meningeal disturbance. The vomited matters consist partly of ingested material and partly of fluid that has transuded through the gastric and intestinal mucosa. Accompanying and following the emesis, there may be spasmodic contractions of the diaphragm, constituting hiccough. This often becomes a very annoying symptom.

In addition to these digestive symptoms there is anorexia, and also great thirst. The tongue is thick, dry and coated. The belly is as a rule soft and flat, but occasionally it may be concave and quite hard. By palpation we can often make out fluctuation in the bowels, due to their being filled with fluid. In some instances there is acute abdominal pain, in the majority of cases however, the sensation described is one of heat and pressure around the umbilicus.

At the same time other portions of the economy are affected, the circulatory apparatus being profoundly involved.

At the onset of the attack there may be acceleration of the heart's action, amounting almost to tachycardia. The patient will complain of palpita-

tion and a feeling of weight at the precordia, causing him anxiety. Soon however progressive heart fatigue comes on, which becomes more and more pronounced until there is decided cardiac enfeeblement, and on auscultation, the heart-sounds are faint, so faint indeed may they become, as to be almost inaudible. The radial pulse becomes very quick and small, and in a severe case may, after a few hours, entirely disappear.

This functional reduction of the circulatory apparatus, is quickly evidenced in the general condition of the patient, and his appearance. The face and extremities grow cool and then ice-cold, and this change will extend to the whole body. Put your hand into the bed and feel the patient's feet, and they will be cold as any stone; then feel to the knees, and so upward, and upward, and all will be cold as any stone; and his countenance and expression will in a most marked manner, change and exhibit the pencilled tracings of the stark and evil genius of the white and cold death. You know how years and trouble can alter expression; you remember how eloquently Sir Walter Scott speaks of this in "Marmion:" how

"Danger, long travel, want and woe
Soon change the form that best we know;
For deadly fear can time outgo,
And blanch at once the hair:
Hard toil can roughen form and face,
And want can quench the eye's bright grace,
Nor does old age a wrinkle trace
More deeply than despair."

But what want and woe and despair, would require

perhaps years to accomplish, cholera will do in as many hours. You know of the horrible deformities, that cancers will produce; you know of the great facial tumefaction that small-pox induces; but Asiatic cholera does not deform, and there is no condition that not deforming, can so thoroughly change the lineaments of the face, so completely alter expression, in a short period of time, as does cholera. Almost as you gaze upon him, the stout, healthy-looking, rosy-cheeked, handsome youth becomes changed into a thin, cadaverous, ashen-hued old man. The complexion becomes livid, and bluish-gray; with lips dry, cracked and almost black, so dark are they. The mouth is sore, often bleeding, the tongue is coated, and the patient will complain of intense thirst. The eyes sink back into the cavity of the orbit and are partially open, with often a thin film seen covering the lower half, while the cheeks become hollow and fall in towards the mouth. The skin loses its elasticity, becomes shrivelled and wrinkled and is bathed in a cold, clammy sweat. Sometimes the lips are drawn into a spectral, sardonic smile, and a ghastly expression, the shadow of death, comes over the whole face. The depressed surface temperature is not only appreciable but is demonstrable by the thermometer, which may indicate a reduction to 35° C. (95° F.,) and even lower, while there may be at the same time febrile temperature in the rectum. The mental field may remain unclouded to the end, but as a rule there is great apathy, and perceptive acuity is much impaired. Few patients are restless and active, more or less hebetude being the rule. Reflex

action is impaired, the voice becomes husky and hoarse and weak, and respiration becomes laborious and more and more superficial. In this state it is often difficult to determine whether in a given case, the individual belongs to the quick or the dead. Dr. Vanderpoel relates that a girl apparently dead, during the epidemic in New York, of 1832, was left in the dead house for some undefined reason, when the other bodies were removed. Her appearance did not change, and so she remained for five days. On the sixth day there was some sign of life, and she **recovered, but with ulcerated corneas.** .

A characteristic symptom of cholera is muscular cramps. These are very painful, and consist of tonic contractions of the muscles, especially those of the calf of the leg, but involving also those of the toes, thighs, arms and hands. These cramps may occur spontaneously, or upon the slightest provocation.

We may find the skin affected, with an eruption which assumes various characteristics. Most frequently it resembles that of measles, and is more abundant about the forehead, eyelids and forearms than elsewhere. When pustular, the back in its lower half, or reaching as high as the shoulders, is **most often involved.**

In a well developed case of cholera there is a decided lessening of secretory power. The mouth is dry from deficiency of saliva, and there is oliguria or even anuria. What urine is secreted, is highly concentrated, with abundant sediment and is often albuminous, sometimes days will pass without the

secretion of a drop of urine, and this condition will persist until death or recovery. In cases that terminate fatally, we find a peculiar dusky look, less bluish than heart cases, in fact really blackish. This is especially noticeable about the extremities. The appearance of the hands and feet may remind us of gangrene, but yet it differs in that there is a shrivelled, shrunken look, and no purpling, the flesh tints showing as through coal dust. Bed sores may be present, and may spread with alarming rapidity after their appearance. Death gradually steals in upon the scene, and the end is usually peaceful; apathy deepening into lethargy, lethargy passing into sleep, sleep into coma, and coma merging almost imperceptibly into dissolution.

The picture I have just given you, taken as a whole, represents the algid period, or stage of collapse, which rarely lasts more than one or two days, usually terminating in some way within from three to eight hours. In many cases death occurs during this stage, and may take place in a few hours, or more frequently in the second half of the first day. Dissolution may be ushered in by deepening of the general prostration, and as we have seen, it may be impossible for us to draw a dividing line between life and the occurrence of somatic death. But in other cases there may be a true compensatory period, leading to convalescence; the stage of reaction. The bowel discharges become less frequent and more feculent, and the vomiting is arrested. The pulse is once more felt at the wrist. The heart's action becomes stronger, the

peripheral circulation is again made manifest, here and there little patches of dilated capillaries will be visible, giving the patient a somewhat mottled appearance, the skin resumes its normal color and soft velvety feel, and not infrequently breaks out in an abundant perspiration. The breathing becomes natural, the mental attributes are brightened, and after a time, the kidneys begin to secrete urine which is almost always quite albuminous and contains casts and discoid blood corpuscles. The appetite returns and the patient is sometimes absolutely ravenous for food. If there be no interference with convalescence, in a few days the urine becomes normal, and after a week or two the patient may be discharged as being perfectly recovered.

Not always however, in this favorable manner, do our patients pass to recovery, but there may be repeated relapses into the previous condition, and sometimes unfortunately with fatal result. Or instead of the convalescent period, the patient will pass into a condition resembling very strongly the third week of enteric fever, and called *cholera-typhoid*. This stage is subject to manifold variations in its clinical manifestations and exciting causes.

As I have said, cholera-typhoid may present all the appearances of enteric fever, with a severe febrile movement, headache and mental dulness. The pulse is full and rapid, the expression is heavy and the face flushed, the lips and tongue are dry, and there may be abdominal tenderness and tympanites. The choleraic-eruption may be present on the skin, especially of the extremities, and assumes the form perhaps

of an erythema, a roseola or an urticaria. In severe cases there may be insomnia, coma-vigil, and delirium, especially at night. This condition may persist for a longer or shorter period of time, when recovery may ensue, or the patient may pass into one of the following states.

In the first of these conditions (the second variety of cholera-typhoid), we find the development of the most diverse local inflammatory processes. There may be a severe dysentery or a violent diphtheritic inflammation of the wall of both large and small intestine, accompanied by numerous painful discharges of purulent and bloody material. There may be pneumonitis, or purulent bronchitis, or serous or purulent pleuritis, diphtheritic laryngitis, pharyngitis, cystitis and extensive inflammation of the genitalia, particularly of the female. You will now and then find parotitis, and sometimes erysipelas and general pyemia. Occasionally there will be ophthalmia, keratitis and corneal ulceration, and inflammation of the meninges of cord and brain. Cases that recover are often troubled by, and for a long time have to be treated for, otitis media suppurans. In addition to any of these symptoms, or varied groupings of the same, you will remember that intestinal symptoms, and those of inflammation of the kidneys, may co-exist, and you have a clinical picture of great complexity. Should death not supervene, any or many of these complications may cause future trouble, constituting prominent sequelæ.

The third variety of cholera-typhoid, is the uremic form. Here the patient exhibits all, or nearly all,

the special symptoms of a severe nephritis. There may be absolute anuria, or if any urine be secreted, it is small in amount and contains numerous casts, is albuminous, and you will find on examination renal epithelium and leucocytes and discoid corpuscles. Earlier or later, but usually near the end of the first week, grave nervous symptoms supervene which must be regarded as uremic. These are the classical manifestations of removal of the kidney function from the economy, and we find headache, vomiting, somnolence deepening into coma, or delirium and convulsions. As a rule these cases are fatal.

Before leaving this portion of our subject, let me ask you to look for a moment at the connection between the morbid anatomy and the exciting causative factor of the disease, or again between the pathological changes and the clinical aspect. *First*—Remember that the comma-bacillus is found only in the cavity of the intestine and its wall, never in the blood or other portions of the body. The extra-physiological state of the intestine so produced, explains the intestinal symptoms, but not the general ones. *Second*—As a result of the great drain of water from the system, caused by the profuse colliquative discharges, there is a positive desiccation of the body which can not fail to cause most profound changes in the tissues; which can not fail to cause a most intense disturbance of the general processes of nutrition. A special disarrangement is that of the heart, one factor in the production of which is the decreased amount of liquid on which it has to act, and the decided departure from the normal stan-

dard of the blood. But this explanation will not suffice for all the symptoms, for circulatory disturbances and cardiac failure may occur in the most intense forms of cholera, before large evacuations have appeared, nay as we have noted, death may supervene without the occurrence of a single stool. You will bear in mind in this connection, the close sympathetic relation that exists between the heart and the abdominal viscera. *Third* You recollect the toxins we have studied in connection with the vital processes of bacterial life, which when isolated and injected into animals produce disturbances identical with the general symptomatology of cholera. We can account for these symptoms therefore, by assuming the absorption by the blood and lymphatic vessels, of these noxa, of their coursing through the delicate capillaries and producing their fell effects on the tissues, and here I would have you remember that the blood itself is a highly complex and complicated tissue, and suffers *pari passu* with the other tissues.

As to the complications that we have found in the later stages of the disease, and that we have studied under the name of cholera-typhoid, I may say that they are secondary, and are not caused by the cholera process, which is however the occasion for their appearance.

The diagnosis of a case of cholera has no difficulties at all during the prevalence of an epidemic. The only affection with which it could be confounded is cholera nostras or cholera morbus, the severe summer choleraic diarrhea of our own climate. The

clinical manifestations of the two maladies are identical. We have the collapse, vomiting, the rice-water discharges, the muscular cramps, and cyanosis in both disturbances. In enfeebled persons, the very young and the very old, cholera morbus may kill in twelve hours, and there will be the same pinched, peaked expression seen as in true cholera. For various reasons it is necessary to differentiate between the two conditions. This can only be done by one, cunning and skillful in technique, well versed in methods and thoroughly acquainted with the diversified bacteriological botany of the bowels. Of course as soon as Koch's comma-bacillus has been found, the diagnosis is complete.

From your studies in general toxicology, you will recollect that arsenic, corrosive sublimate, and certain fungi produce a symptomatological grouping that in many respects resembles cholera, but the difficulties in differentiation are slight.

The prognosis varies with the intensity of the disease in a given epidemic, with the age, previous condition of the individual and his surroundings. Intemperance, pre-existent disease of any kind, debility and old age are unfavorable conditions. The disease is also very fatal in childhood, and amongst those whose previous diet has been improper and whose hygienic surroundings have been bad. The prognosis is always uncertain, as the mortality ranges in different epidemics from thirty to eighty per cent. During the occurrence of a given attack, the prognosis becomes graver in direct proportion with the development of the characteristics of asphyxia and

cyanosis. The more rapidly the collapse sets in, the greater is the danger. In about two-thirds of the fatal cases death occurs during the first days of the algid stage, and about one-third during the period of cholera-typhoid. Cases with marked cyanosis and very low temperature rarely recover.

To recapitulate; as to the preliminary diarrhea, the patient may recover from it, or from six to twelve, or twenty-four hours, or even two to three days it may persist and then be succeeded by the algid period. Its average duration is about twelve hours, while the average duration of the stage of cholera asphyxia is from three to six hours. Convalescence sets in usually from twelve hours to four days after the appearance of the first manifestations. The typhoid period is very variable as to length, lasting from five days to two weeks, and even longer.

In studying the history of cholera epidemics, we have seen how frightful the mortality may be, and novelists and artists and writers have drawn on these scenes, to describe some of the most fearful and gloomy pictures ever portrayed by pen or pencil, to human understanding.

LECTURE VI.

At our last meeting, we studied the symptomatology of cholera, we stood by the patient's bedside and contemplated his sufferings, and to-day it becomes our duty to note what can be done to alleviate the pains of the disease and relieve the sick-man.

An old, pithy proverb of our fore-fathers is, "An ounce of prevention is worth a pound of cure." This saw is very applicable to our subject, but I would modify it by saying, "A grain of prevention is worth many tons of cure." It is our prime duty to prevent disease, not to wait for its onset, and then try curative measures, and you must never consider your work as being circumscribed by narrow boundaries, or as being confined to the mere administration of physic. Far broader must your horizon be, far wider your scope; you are high priests of health, you are teachers of men, and as members of the great faculty of medicine, your first duty will be to preach and practice physical and moral cleanliness.

Cholera being an infectious disease characterized by the constant presence of the Koch-comma-bacillus in the intestine and its contents, any measures used to destroy this specific, morbid micro-organism, to prevent its development, or to preclude its introduction into the animal economy, are of essential importance in connection with prophylaxis. Certainty as to results of prophylactic measures postulates the strictest detail attention to the hygienic and sanitary surroundings of the community, the family

and the individual. In this age, with the aids given by bacteriology and sanitary science, an outbreak of Asiatic cholera is *criminal* and is a blot upon the escutcheon of nineteenth century civilization.

Commencing our study of treatment, by considering prevention, I now invite your attention to the question of prophylaxis.

Municipal and National authorities should endeavor to combat contagion: 1st. By not furnishing to the scourge a favorable field for its development. 2nd. By preventing the development and propagation of the malady, once it has infected a locality.

The general measures to be put into execution in such cases may be summed up as follows:

a. Fecal discharges must never be allowed to, in the slightest way, infect or vitiate drinking-water supplies.

b. Unhealthy, dirty lodging houses must not be tolerated.

c. For drinking purposes, use only water that you are absolutely sure is pure, and never vitiate pure water by direct contact with ice.

d. Disinfect properly, or destroy, all clothing, utensils, and apparatus used by a cholera-patient, or in the management of cholera cases.

e. Do not place cholera patients in the wards of general hospitals, they must be isolated in especial hospitals.

Remember, that in the event of cholera ever visiting the locality in which you might be living, that you and your colleagues in the medical profession,

will all be medical officers of health; that you will be, by virtue of your profession, aids to the sanitary authorities, and that it behooves you to prepare yourselves, and be ready, and able and willing, to do your utmost towards the preservation of the integrity and good health of the commonwealth. In connection with municipal measures, the following excerpts of Dr. Raymond, cover so thoroughly the ground, that I would ask you to transcribe them in your note books for future reference.

All surface wells should be closed at the earliest possible moment; and great care should be taken that the water supply of all cities, towns and villages shall be of *undoubted* purity. In cities or towns where the water supply comes from the country, at a distance from the city or town, and where there is always danger of contamination from stables, slaughter-houses and privies along the banks of streams; special inspection must be made of these sources of danger, and where ever a nuisance is found, it must be promptly and positively abated.

All privy vaults should be abolished wherever water-closets can be supplied; and wherever the existence of such vaults is necessary they must be rendered water-tight in such manner as to prevent saturation, not only of the grounds surrounding them, but also of the materials of which they are built; and the contents of such vaults must be kept constantly disinfected, and removed to a proper place at frequent intervals. Too much attention can not be paid to the disposal of the contents of privy vaults. During the existence of an epidemic, or if there be

suspicious cases in the town or neighborhood, under no consideration should night-soil be removed to farm lands or used as fertilizer, but the material should be absolutely destroyed.

In city, suburb, town or country, all stagnant ponds should be disinfected, and when possible the water should be removed by drainage or pumping, and the further accumulation prevented by filling with fresh earth or other material free from garbage or other filth.

Great care should at all times be exercised to keep all sewers which receive refuse from dwellings, factories and other buildings, clear and free from obstruction; and examinations should be made as to the plumbing in all buildings, and any defects discovered should at once, be corrected. The sewage and water-supply questions, are burning ones, and demand careful consideration. Taking our own city for example; let us see from whence we get our drinking water, and where do we pour our refuse matters. Leaving out our artesian well waters, and those of various springs, whose waters brought to Chicago are used by only a comparatively small fraction of the entire population, the source of the water supplied for domestic and other use is from the Lake, which laves the feet of our right royal city. We have two main outlets for our sewage; Lake Michigan, and—through the Chicago River—the Mississippi River. In its state of nature, the Chicago River was wont to flow into the Lake, but as it receives a very large proportion of the city's filth, in order to prevent all of its vitiated stream from pour-

ing into the drinking-water source, our municipal authorities have attempted to cause its current to flow backward, by building a powerful pumping station some distance up, on its southern fork. Here over a lock into a canal, the river water is pumped, and after a devious and variegated course, it ultimately reaches the Mississippi River. But while the great bulk of the liquid sewage is thus disposed of, there are a number of sewers serving the shore districts of the city, that open directly into the lake, and while their total output is *relatively* small, it is *absolutely* large. The current in the Chicago River is very sluggish and lazy, for the greater portion of the time, and there is therefore a continual deposit of suspended matter on the river bottom. This sludge is removed by dredging and carried out and dumped into the Lake, which thus receives effete material in addition to the discharge of the sewers serving the Lake Shore districts. From various points out in the Lake lying at no great distances from the sources of pollution, water is taken, and by means of subterranean aqueducts beneath the floor of the lake, is conveyed to pumping stations in different parts of the city, to be distributed through the city mains, to the consumers' houses without having undergone filtration or any treatment whatever. Now, unfiltered, this water is absolutely unfit for consumption, on account of its suspended matter, and our security from epidemics depends entirely on the thoroughness with which the Lake water is filtered or otherwise purified before being used. No matter how carefully this may be done, it is of no value, if after purifica-

tion the water is allowed to be exposed to the air for a considerable length of time, or vitiated by direct contact with ice. I have shown you in one of my early lectures, that the spirillum cholerae Asiaticæ is not destroyed by freezing, and it can be imprisoned in a block of ice, set free by the melting of its jail, and exhibit its pristine vitality, to the fullest extent. Those of you who are at all familiar with the facts, will bear me out in my statement that the condition of the Chicago River, is positively disgusting. The degree of pollution that is found in its waters, is alarming, the stream being really nothing more than animal refuse mixed with common sewage, and its condition demands immediate attention. The question here to be answered is: "Does this state of affairs affect the health of the city?" To this I will not attempt to give an answer, but will simply make the following remark: In the year 1890, Chicago suffered nearly eight times as much as London, from typhoid fever, and nearly twelve times as much as London in 1891.

Extraordinary care should be exercised in reference to all tenement houses, lodging houses, and in general all places where large numbers of human beings congregate; frequent and thorough cleaning and whitewashing of such structures should be required; no accumulation of garbage or other filth ought to be permitted in cellars or yards; and householders should frequently and thoroughly examine their yards, cellars, closets and other out of the way places, to see that no filth of any kind has been deposited therein. There is some difference of opinion

concerning the specific value of rags, as etiological factors in spreading cholera. Dr. Allan McLane Hamilton, of New York, places stress on their importance in this respect, while Dr. S. T. Armstrong of the same city claims that not a single instance can be given wherein it can be shown that rags have spread or conveyed the disease in this country.

The food supply should be vigorously watched to exclude from the market all unwholesome meat; all milk adulterated, or from diseased animals; all unripe fruit and vegetables; and cow stables should be kept at all times, clean, well whitewashed and free from all excremental accumulations.

Here in Chicago we have little, if any, complaint to make in this regard. A short time ago our City Council passed an ordinance with reference to milk inspection, that in all probability is the most perfect measure of its kind, to-day in force.

All garbage, kitchen and household refuse should be promptly removed from dwellings, stores and other buildings to a proper place where it may be destroyed by fire or otherwise disposed of in such manner as to occasion no nuisance; and such material should never be used in the filling of lots or thrown in streets or vacant property to decompose and exhale offensive and deleterious gases.

Too much attention can not be given to the instruction of the public as to personal cleanliness. You must remember that the most effective preventives of cholera are the effectual cleansing of places and of persons.

A very important question, that I feel it to be a

duty to touch upon here, is as to the disposal of the dead. As you are aware, to-day the method in vogue is that of earth-burial. Now while this mode was correct in days gone by, I am forced to say that in our time, it looks to me like a relic of medieval barbarism. This is not the occasion, nor have we the time to thoroughly review the merits of cremation or of inhumation; but I desire to direct your observation to some salient points connected with the matter.

Dr. Petrie, of the Department of the Interior in Berlin, not long ago published a paper in which he claimed that cemeteries were perfectly safe if situated in proper soil and managed correctly, but in the discussion of his paper it was shown that pathogenic bacilli had been found in the earth three years after bodies had been buried. It has also been shown that in places where persons dying of yellow fever had been buried, bacilli identical with those found in the excretions of the yellow-fever patients have been discovered only a few inches below the surface of the ground. In the *Sanitarian* you will find a most thorough and scientific paper on this subject from the pen of Dr. Robert Newman, who favors cremation in a most decided manner as a prophylactic measure against epidemic diseases.

Nothing can be found in the bible which can be construed as opposed to cremation, and many ministers of the gospel now favor it. "He who can make men from the dust can bring them from ovens as well as from graves."

Newman quotes the fact that anyone who drank

water from the Elbe, during the last epidemic in Hamburg, was looked upon as being a cholera-suspect. Biernacki found in the well in Lubin, a suburb of Hamburg, cholera spirilla. That well was near a single house, in which in a few days twelve persons were seized with cholera. All these had been drinking from that well. Professor Frenkel, of Magdeburg, found comma bacilli in the Rhine-Ruhr Canal where a boat had been anchored whose owner had died of cholera, and where his excretions had been emptied.

Earth in graves through burials, may cause a new epidemic.

Sanitary Commissioner Doering in Berlin, has demonstrated the existence of living cholera in graves, and has shown that the germs may be liberated by water, and thereby create the disease.

A proof of this can be adduced in an incident which occurred in New York during the epidemic of 1866, when some emigrants dying of the disease, were buried in Ward's Island, and shortly after a new epidemic appeared in the city opposite the Island, in Ninety-Third Street, near Third Avenue for which no explanation could be given except of infection from the graves.

From the standpoint of the sanitarian, therefore, the correct mode of disposing of our dead, is by cremation.*

*In a late number of the *Revue des Deux Mondes*, M. Deherain contributes a paper entitled "Fermentation of the Earth," in which he discusses the question, "Can earth give infection?" He points out that "Those who are acquainted with Eure-et-Loire, with Oise, or Seine-et-Marne, have heard of the accursed fields on which the shepards refuse to feed their flocks. It will

Another point of interest, is that contagion may be carried by flies. Gatti, Grassi, Koch, Simmonds and others authorize the statement that flies have transmitted cholera. They kept flies that had been seen sitting on cholera corpses, at their laboratories, and demonstrated to their satisfaction that flies can carry comma bacilli. The police authorities of a town in Prussia are said to have issued a proclamation against flies. The decree states that, inasmuch as flies contribute to the spreading of cholera, citizens are commanded to exert themselves to the utmost to destroy all flies within their houses. The proprietors of beer saloons are ordered to keep fly-catchers on their counters, and penalties are provided for neglect or disobedience of the order.

During an epidemic of cholera, milk is one of the means by which the disease is propagated, the germs being carried by the water used to contaminate that fluid-food. It has been found that the bacillus of cholera thrives in milk as well as it does in water. To purify the milk it is not enough to filtrate it, nor is it advisable to add to it alum or an acid, because the fluid must be pure, particularly when it is to be given to children and sick people. The milk should be boiled. It is then destitute of all microbes and never produces diarrhea.

The best and easiest method of sterilizing milk is that proposed by Soxhlet. The amount necessary to use for once, is placed in a bottle, and is then

be found on investigation that animals stricken with disease have been at a former time buried there, and that a direct infection can and has been passed through the vegetation growing up above."

heated by means of boiling water (water-bath) for a period of from thirty to forty minutes. The bottle is then taken out, and corked with a rubber stopper and metal covering, in order to avoid the entrance of outside air.

Butter should be avoided during an epidemic, since the bacillus of cholera lives in this article of food for from thirty to forty days.

Meats, vegetables and fruits should never be eaten raw, but should always be thoroughly cooked before being used as food.

Coffee, tea, boiled water and milk, beer, and wine and water, are recommended as beverages, during an epidemic, also acid drinks, lemonades, etc.

Theodor Weyle, of Berlin, found that the comma-bacillus does not thrive well in beer. This result Weyle attributes to the acid reaction of beer. It is, however, important during a cholera epidemic to cleanse the beer-glasses with sterilized, or boiled, or hot water. Weyle examined various brands of beer during his investigations.

Pick has demonstrated the inhibitory action of wine, or wine and water, upon the cholera spirillum, for after an exposure of but from ten to fifteen minutes, no living germs could be found. The same result followed twenty-four hours' exposure. During the prevalence of a cholera epidemic, it is, therefore, advisable to add to the drinking water an equal quantity of wine, and it will be an object of further investigation to determine how far the thinning of the wine may be carried, and how long these mixtures should be allowed to stand, in order to be cer-

tain that the germs of the disease contained in the water are entirely destroyed. It will also be advisable only to drink the wine from vessels in which it has already stood for twenty-four hours, and to mix the water and wine twenty-four hours before its use. There were various good reasons for Paul the Apostle to advise his colleague, Titus, to "Take a little wine for the stomach's sake," and his advice holds good to this day especially during the existence of an epidemic.

During an epidemic, do nothing that could possibly disturb the equilibrium of your economy, especially of your digestive tract. Therefore, avoid excessive fatigue, and all depressing passions, for they are injurious. Do not suddenly check perspiration, and if overheated, beware of a sudden chill, and keep the skin comfortably warm. Sufficient covers should be made use of at night, and it is advisable to wear flannel under-clothes. Even in summer it is a good plan to wear a wide flannel belt round the body, covering the stomach and bowels. Diet must be carefully attended to. Bad digestion diminishes the secretion of normal gastric juice, the acid of which is essential to counteract the baneful activity of the comma bacillus. I would not make any change in my usual diet, if cholera invaded Chicago, but would see that it was simple and easy of digestion; you should eat moderately, and at regular intervals, as long fasting is injurious, and you must carefully avoid excess in intoxicating beverages.

The idea so prevalent among the laity, that brandy

and whiskey are prophylactic agents against cholera, is a false one; they are not preventives and unless carefully used, may do serious harm by disordering the action of the stomach and bowels.

Contact favors the transmission of cholera. Thus, members of the family, nurses, physicians who attend cholera patients and touch the bodies of these, as well as the utensils employed, clothing, articles of food, matters vomited, the dejections, and so forth; are all apt to carry about the germs of the disease. The scourge may be transmitted by placing a soiled hand to the face, by hand-shaking, by a cigar, in the simplest way imaginable, and thus constant washing of the hands at such times is of the utmost importance.

Not only the home-dwellings, but also public places, like hotels, should be kept scrupulously clean, and the removal of all sources of infection should be similarly supervised, suppressing even the slightest bad odors from stairs, corridors and particularly closets.

The mouth being a common source of infection, it and the teeth should be frequently washed and brushed during the day with boiled water, pure or mixed with soap; after which the mouth should be rinsed with a solution containing citric acid, an acid which is inimical to the cholera germ. As a fluid dentifrice and wash for the mouth, Listerine is excellent. The nasal cavities should likewise be treated with disinfected water, since infection may be transmitted through the mucous lining of the nose.

Finally, living near by, or even frequenting, the vicinity of sewers or filthy water streams, ponds, marshy districts, etc., should be avoided.

As a purely prophylactic measure, Winternitz recommends water *régime*. It acts in two ways; it furthers cleanliness, serving to disinfect the person, and it has a tonic, hardening effect, which improves digestion. Winternitz pursues the following course. When the skin is dry, sluggish and neglected, he has the individual well rubbed down with moist or dripping cloths wrung out in water at about 10° C. (50° F.) Where the person is more robust, a half bath at 20° C. (68° F.), lasting two minutes, may be given; or in a well developed, strong man, a general shower-bath, even quite cold, lasting a half to a whole minute, may be indulged in. These baths should always be followed by brisk rubbing down with coarse towels, or flesh brush, and a normal reaction induced. They are best taken in the morning, and exercise in the fresh air, or room gymnastics must be attended to. In some cases the procedure may be repeated in the evening. Care must always be taken that the individual does not bathe in such a manner as to cause depression; but bathe he should, for as we have already seen, strict personal cleanliness is absolutely a necessity. If weakness, or disturbances of digestion of a trifling nature are present, Winternitz advises the application before retiring, of a Priessnitz bandage, an irritating application, about the abdomen.

The medical profession has been accused of pessimism, and its members rated as alarmists. By

your actions you must prove the falsity of these accusations. Do not be afraid of cholera, or make it the subject of conversation, especially with the laity; do not allow interviews to be published in the daily press expressing opinions as coming from you of a gloomy nature, but do not shut your eyes to danger, do not say there is safety, when there is no safety; but remember that if eternal vigilance is the price of liberty; unremitting, unsleeping, eternal vigilance is what we must also give for health.

I have only outlined to you in a general way, prophylactic measures against cholera. From works on hygiene, from comprehensive text-books you will glean fuller and more complete information, and every hour so spent, is an hour well spent. For I am certain you appreciate that the key-note to the medical practice of the future, is the word "*Prevention*," and in conclusion let me quote the epigrammatic advice of the New York Board of Health, which you will do well to bear in mind and live up to, should you ever pass through a cholera epidemic, "*Don't* be frightened, but *do* be cautious and avoid excesses and unnecessary exposures of every kind."

LECTURE VII.

After having considered all that can be done to prevent the occurrence of cholera, we pass to the study of the treatment of the disease once, it has appeared.

On being called to a house to attend a case of cholera, in your anxiety for the salvation or cure of the sick man, you must not forget your duty to the community. You must bear in mind that the sick man is a poison-producer, and on this account, is in a certain sense, a foe to the commonwealth. Your treatment must therefore be directed along the two following lines: 1st. That which concerns the patient as an individual. 2nd. That which is connected with the prevention of the spread of the disease. The Committee on Disinfectants of the International Sanitary Conference of Rome, recommends, as a means of disinfection against cholera, besides destruction: 1. Steam at 100° C.; 2. Carbolic acid or chloride of lime. 3. Aëration.

Sternberg directs the use of two solutions, one weak, the other strong, of carbolic acid and lime chloride in water, as follows:

Weak Solutions: Carbolic acid, two per cent.; lime chloride, one per cent.

Strong Solutions: Carbolic acid, five per cent.; lime chloride, four per cent. These solutions should be kept in large blue glass bottles, plainly labeled, with directions and formula written thereon, and the word "poison" in good-sized letters. They should always

be kept in the same place, not changed from one part of the room, to another part of the room, nor from room to room. In addition there should be kept in the water-closet, a very large bottle or jug, which should be constantly filled with strong chlorine water. You must impress upon everyone connected with the case, the necessity of obeying your orders and you will see that the following measures are put into practice: Dejections must be received in a porcelain bed-pan or *pot-de-chambre*, the patient not being permitted, even in the earliest stage, to use the closet. Into the vessel there must then be poured one of the strong disinfectant solutions, in quantity at least equal to the amount of material to be disinfected; the whole mixed carefully but thoroughly by shaking, allowed to stand about ten minutes, and then poured into the hopper. Then into the hopper there must be immediately thrown about two quarts of the strong chlorine water. In the same manner must vomited materials be treated, and in both instances when the foul matter has been cast out, the vessel must be scalded with boiling hot water and then rinsed with one of the weak solutions, before being returned to the bed room. All feeding utensils used by the patient, such as spoons, glasses, dishes, basins, must be at once washed in boiling water, then rinsed in one of the weak solutions, and then cleansed in pure water. All linen, clothing, bedding, etc., which can not be immediately subjected to the action of steam, should at once be immersed in one of the strong solutions, left there for from four to six hours, then boiled for at least thirty minutes, well washed

with soft soap, and then hung in the open air for from 12 to 24 hours. Physicians and attendants should wash their hands with one of the weak disinfecting solutions every time they touch or handle a cholera patient or his clothing, etc. Especially must attention be directed to care in this respect, with those who handle soiled linen and bed clothes.

Should the patient die, the body must be enveloped in a sheet, saturated in one of the strong solutions, without previous washing of the corpse, and at once placed in a coffin.

Whether the patient lives or dies, at the termination of the case the mattress, carpetings, tapestry and hangings of the room occupied by him, as well as the coverings, must be destroyed by fire. The sick room and adjoining chambers should be well sprinkled with one of the strong disinfecting solutions, the floors and walls washed with one of the weak solutions, and then freely ventilated, cleansed and repainted.

In connection with treatment the following outline has been prepared by me and is offered only as a suggestion of modes or plans to be followed.

First. You are to endeavor to prevent, in every way possible, the admission of the germ into the system; and with this end in view, you will pay attention to—prophylactic measures connected with the community, and—prophylactic measures connected with the individual.

Second. Inhibit the growth and development of the spirilla in the intestinal cavity.

Third. Obviate the local and general specific effects of the germ and produced toxins on the system,

such as diarrhea, emesis, collapse, anuria and arrest of secretion generally, coma, cramps, singultus, and so forth. Important conditions to be considered are the dessication of the system and the pachyemia that occur as results of the enormous flow of water from the economy.

Fourth. Promote free and thorough elimination.

Fifth. Sustain vitality. In order to do this you will supply warmth, stimulation and nutrition, and endeavor to render fluid the thickened blood.

Sixth. Obviate as far as possible complications and treat them as they arise.

Bucquoy points out that three results are to be sought after in each case: 1st. To maintain the bodily temperature of the patient at normal; 2d. To combat the diarrhea; and 3d. To arrest the vomiting. Now there are three things to which I particularly direct your attention: 1st. During a cholera epidemic every case of diarrhea should be treated as the first stage of an attack of cholera, and the fact that the preliminary diarrhea is mild does not indicate a corresponding mild attack of the disease, for sometimes a very severe algid period will suddenly follow on the heels of a rather ordinary diarrhea. Do not wait until the stage of collapse has arrived before you think of doing something for it, it may then be too late. All through the first stage, your treatment must more or less trend in the direction of collapse obviation, and bear in mind that cholera asphyxia comes on often like a stroke of lightning. A patient in the initial stage of true cholera, may be likened unto a man blindfolded and walking along a level plot to-

wards a steep, precipitous inclined plane of slippery ice. If he is to be saved, it must be before he reaches the edge of the precipice. If he comes to the edge, his feet slip out from under him, and he falls to destruction with terrible rapidity. So in cholera, it is surprising at what a frightful rate of speed these patients will pass from a condition of health to a moribund state. 2nd. In treating an individual in the period of collapse of Asiatic cholera, remember that the normal absorbent functions of the gastro-intestinal surfaces are arrested, and that therefore it is worse than useless to pour powerful drugs into the patient's alimentary canal, as they will not be absorbed, and cannot therefore produce effect. Should the sick man recover from the cholera asphyxia and pass on into the reaction stage, when the absorptive mechanism would once more return to its condition of activity, and the stomach and gut of the patient be filled with strong drugs, sudden death might occur caused by the overwhelming effects of various potent agents quickly thrown into the system. 3d. Bear in mind that a man in the condition known as cholera-typhoid must be treated in just the same way that you would treat a patient in the third week of enteric fever, and that many of the accidents met with in the third week of enteric fever, are often to be encountered in cholera-typhoid.

The literature of the treatment of cholera is excessively interesting, and extends from the description of the most superstitious rites, and the proposal of the most ridiculous practices, to the laying down of the most finical rules that have ever been outlined by

theoretical dreamers, in connection with hyperbolic antiseptic performances or surgical interferences.

From far Russia comes the account of how the inhabitants of a certain village tried to protect their homes from epidemic invasion. How at dead of night a troop of maidens walked in procession around the hamlet, dragging a plough and intoning invocations, and if after this an epidemic should come, it was a certain proof that one, at least of the maidens, had surreptitiously offered up sacrifice at the altar of the Cytherian Goddess. Hardly less remarkable was the proposition of a physician during one of the earlier epidemics in this country to check the diarrhea by stopping up the anal orifice with a properly constructed cork.

At the other end of the scale, we read of an ambitious individual who has of late proposed surgical invasion of the abdominal cavity. As his percentage of deaths, was an even one hundred, his plan could hardly become popular.

It will require a great deal of tact to enable you to safely steer between the Scylla of carelessness on the one hand, and the Charybdis of unnecessary alarm on the other, during an epidemic of cholera. I have already told you that, during such an epidemic, every case of diarrhea, no matter how slight, should receive the utmost care, and be treated on the principle that it may be premonitory of an attack of the disease, and this you must do without causing unnecessary apprehension, or spreading alarm among your circle. You will cultivate yourselves to act "*Suaviter in modo, fortiter in re*," and inform the members of the various

families composing your practice, of the urgent necessity of immediately paying attention to slight intestinal derangements, that under ordinary circumstances might be considered insignificant and disregarded.

Very eminent authorities say that if a slight diarrhea occurs, and it is clearly traceable to errors or excess in eating, and if there is reason to believe that undigested food is still irritating the bowels, a mild laxative may safely be given. No possible harm, says one distinguished author, can result from this treatment, and even should the sequel show that the case was one of choleraic diarrhea, the physician may rest assured that the attack was not aggravated by his remedy. But, continues this same authority, if there is no distinct evidence pointing to the presence of irritating bowel contents, the preliminary laxative is contra-indicated, and treatment by opium may at once be begun. Now I assure you I cannot see the force of this method of argument, and my belief is to treat *every* case on the plan of bowel irritation. Whether it be undigested food-stuff or a morbid micro-organism that is producing the irritation, my plan would be the same; give a mild laxative, such as castor oil, or a dose of salts. In either case, follow up the laxative, with a little opium, syrup of ginger and tincture of capsicum as a corrective. The mildest and most pleasant laxative you can exhibit is castor-oil, but you must thoroughly disguise its nauseating taste, and give it in a rather small dose. I do not believe in large doses of this drug, they are apt to gripe and cause a good deal of discomfort. One

drachm you will find quite sufficient in a very large majority of cases. I never find it necessary to administer over two drachms, and this rarely, as half this quantity usually is enough. But you must disguise the taste of the oil, or give it so that it can not stimulate the gustatory terminal bulbs in the mouth. Now there are numerous methods prescribed for disguising the taste of castor-oil and they are all perfect successes in every way except that they do not disguise, on the contrary they accentuate. Castor-oil has a very self-asserting taste, it is like Mark Twain's story about the smell of the Limburger cheese in the baggage car, it uses the various tastes of the adjuvants as a background and stands out more pronounced than ever. I have never had any difficulty in giving castor-oil under the form of an "artificial oyster," which I do as follows: Take a soft elastic capsule holding a drachm, and lay it on ice until cold. Then put it in a tablespoon and cover with catsup, lemon juice, vinegar and a little horse radish, and have your patient swallow it as he would an oyster. In this way I have given this sickening drug safely to people with very squeamish stomachs.

No sooner, however, has the laxative produced its effect of cleaning out the bowels, than any persistence of diarrhea should be immediately arrested. If there should be stomach distress, an emetic dose of ipecac is highly recommended by Professor Fabre, of Marseilles, who exhibits it not only in the premonitory stage of an attack, but also even when grave phenomena already exist, should the tongue demonstrate gastric disturbance. Fabre remarks that

it is surprising to witness the calm that follows on the vomiting, to observe the pulse rise, a moisture bedewing the limbs, the cramps to cease, the countenance to lose its pinched appearance and the general condition of the patient to improve. •

For the arrest of the diarrhea, many authors still seem to be in favor of the exhibition of some form of opium. Very eminent authorities, however, severely condemn its use. The distinguished therapeutician, Dr. Hare, of Philadelphia, says that we should *not* give opium for the diarrhea, but only for the cramps and pain, and he recommends its use by the rectum. When it is necessary to use it per orem, Hare advises the employment of the denarcotized laudanum. Hare goes on to state that as the bacilli find a strong barrier in the acid secretion of the stomach, and as opium tends to inhibit the secretion of the gastric juice; that therefore opium is contra-indicated. This mode of reasoning is, with all due respect to the quoted authority, to my mind hardly logical. When in the premonitory diarrhea, or first stage of cholera, we are called upon to give opium, the enemy has passed the outposts and is already in the citadel. The spirilla have escaped the action of the gastric free acid and are now where the secretion of the gastric glandular apparatus can not disturb them. I would call your attention to the fact that there is but little use in locking the stable door after the horse, harness and buggy have been stolen. Constantine Paul, in a paper read by him before the Société Therapeutique, advances a most excellent reason for the non-use of opium in cholera. He shows that the kidneys suffer

in this disease, that they rapidly become unable to eliminate the drug, which then becomes a poisonous substance, and adds just that much more to the load of toxic matters the system has to carry.

Hare speaks highly of a drug that I recommend to you for use in this connection, and that is camphor. I exhibit it habitually in cases of cholera-morbus, and it tends to stop the diarrhea and relieve the cramps from the beginning to the end of the attack. It is a general systemic stimulant, and is useful as preparatory treatment looking towards the onset of the algid stage. Particularly beneficial is camphor when used in connection with alcoholic preparations, as it not only tends to control the diarrhea, but also stimulates the torpid kidneys. A much lauded mixture is camphor wine, which is made by adding seventy-five grains of finely powdered camphor to a bottle of strong red wine, to which are also added gum arabic and alcohol. The camphor is first dissolved in the alcohol and then thoroughly mixed with the wine, and the dose is a teaspoonful in peppermint-tea every hour, to a child of six years, while to an older child a dessertspoonful may be given, and to an adult a wineglassful. This mixture is not only valuable on account of the camphor it contains, but also on account of the red wine, which is, as we have seen, of bactericidal importance.

For the diarrhea, a powder composed of fifteen grains of subnitrate of bismuth and ten grains of benzo-naphthol given three times in the course of the day, has been found efficient. Hayem has confidence in lactic acid as an intestinal disinfectant.

Take three drachms of lactic acid; six of simple syrup and thirty drops of tincture of lemon, which are to be mixed and placed in a quart of distilled water. Of this the patient is to receive from one to to three dessertspoonsful every quarter of an hour. A few drops of some mineral acid (preferably sulphuric) very largely diluted with water, may be given frequently with advantage; not only with the hope of interfering, by the acid solution, with the morbid processes in the gut, but also on account of the grateful, soothing effect on the patient. In cholera-morbus, ten drop doses of aromatic sulphuric acid in water frequently repeated, are of great benefit, and would, I believe, be useful in true cholera. Most remarkable results are reported from the use of salol in doses of from fifteen to twenty-five grains every three or four hours for a day or two. Löwenthal finds it very antagonistic to the comma bacillus, and Hueppe is authority for the statement that its use prevents the development of anuria by inhibiting microbic growth and preventing the diarrhea and the appearance of the toxic materials, both of which influence the blood. I believe that a good practice is to administer early in the first stage, a cholagogue. You will find as the diarrhea assumes choleriform aspects that there is an entire absence of biliary pigment in the stools, which are whitish in color. We have already seen that in order to produce the disease in animals, it has been found necessary to tie the bile-duct. Bidder and Schmidt describe bile as diminishing putrefactive decomposition of the intestinal contents, and ascribe to it slight antiseptic quali-

ties, although this is doubted by von Voit. Any such virtues that bile may possess are due to its interference with bacterial development in the intestinal tube cavity. Dalton found that the feces of a dog with permanent biliary fistula, were much more stinking than ordinary, while Bidder and Schmidt noticed abnormal discharges of flatus. I believe it to be of advantage in the early history of the disease to favor intestinal antisepsis, by inducing hepatic activity, causing a free out-pouring of bile into the bowel and then cleaning out the tube. For this purpose I would recommend the administration of small doses of podophyllin, aloes, euonymin, iridin or blue mass. A five grain blue mass pill given in the neighborhood of three or four hours before a dose of castor-oil, is good treatment.

In studying the chemistry of cholera micro-biology, you recollect we found that certain noxa were produced during the processes connected with the growth and development of the cholera germ in the bowels. Turn back to your notes and read the symptomatology of cadaverin-poisoning, as tabulated by Scheuerlin and Grawitz. Read further and note Kober's observations on the muriate of cadaverin, which he found to be a very mild kind of poison, it indeed a poison at all. A similar attribute he noticed as belonging to other salts of the alkaloid; as for instance, the tannate, lactate and citrate. A question to be answered in relation to treatment, is how to convert the produced cadaverin into a harmless salt. There are three localities in which we find this toxin, and in which we have to attack it. These are: in

the bowel, in the blood, and in the tissues of the system.

Dr. Heir in Hyderabad, believes that the best results can be obtained from the use of salol, which in the bowels becomes split up into carbolic acid and salicylic acid. He recommends the administration of nine grains four times a day. This is also the *rationale* of the acid treatment which I have before spoken of, the conversion of the toxic animal alkaloid into a lactate, a citrate or a sulphate. In these methods two ends are aimed at: 1st. To so alter the medium in which the bacilli are growing and living in the bowel as to render it inimical to them; and 2d. To convert the toxine (or toxines) into harmless material.

Cantani believes that the best means at our disposal for accomplishing the two results above mentioned, are included in the method of enteroklysis, or washing out the bowel, introduced by him within the last decade. This mode yielded such brilliant results in his hands that he enthusiastically employed it in a very large number of cases, and induced many other physicians to try it. He holds that for the operation to be successful, it must be performed rather early in the history of the disease in a given case, and it must be performed as directed by him. The *modus operandi* consists in the slow irrigation of the large and small bowel by way of the rectum, with a solution urged on by the hydrostatic pressure of a fountain syringe. The solution is composed of: infusion of chamomile flowers, two thousand parts; tannic acid, ten to twenty parts; gum arabic, thirty parts; and tincture of opium, two parts.

Cantani insists that in order that the operation should be successful, the ileo-cecal valve must be passed, and that in favorable cases where the operation was a failure, no more was done than to irrigate the colon. The importance of irrigating the ileum is very great, since it is here the disease is most active. He uses for each injection two quarts of his injection fluid at a temperature of from 101° to 105° F., and gives it so slowly that the bowel hardly appreciates that it is being distended. The beneficent effects claimed are; contraction of the leaking vessels, inhibition of the growing of the bacilli, lessening of the absorptive capability of toxins, the changing of at least a portion, of the toxic alkaloids into comparatively harmless salts, the acidulation of the intestinal contents, the warming of the body, the prevention of anuria and desiccation of the tissues, and the obviation of collapse. Theoretically, could any treatment be more perfect, and if practical results only bore out the theory, we would have almost, if not absolutely, a *specific* treatment for cholera.

Oser thinks the enthusiasm of Cantani and his disciples to be premature, for he asserts that the death rate has remained as high in Naples since the method of enteroklysis was introduced, as before. Oser states that he cannot say whether or not the ileo-cecal valve is paralyzed in cholera, as he has not made any experiments in this direction, but he is inclined to the opinion that under ordinary circumstances the valve is impassable. He feels certain that with only two quarts of fluid, it is impossible to wash out the whole small intestine and sterilize the bacilli in the

upper part. Bull has found that in the adult a little over a quart of water injected by the rectum will reach the cecum, but that the entire capacity of the large intestine is from four to somewhat over five quarts. He is of the opinion that in the living body fluid can not be forced beyond the ileo-cecal valve, although ancient and modern experimenters claim to have succeeded in the cadaver. He affirms that when the large intestine is distended by air the ileo-cecal valve is rendered incompetent and the air passes into the small intestines. Heschl has made numerous observations and declares himself as being satisfied that the valve is an absolute barrier against regurgitation from the large into the small intestine. In experimenting as to the resistance afforded by the various coats of the bowel, to pressure, he found that the peritoneal coat of the colon yielded first to over-distension, the remaining portions of the wall giving way subsequently to a somewhat slighter force. On being subjected to hyper-distension, the small intestine of a child ruptured first on the mesenteric side, the place where acquired diverticulæ are found. Other opposition to Cantani's procedure comes from the authorities of the Moabit Hospital in Berlin, who have no confidence in it whatever.

Probably the highest authority in the world on this question is Nicholas Senn. This brilliant investigator asserts that the results of carefully conducted experiments combined with clinical experience leave no further doubt that, practically, the ileo-cecal valve is not permeable to fluids from below, and that for diagnostic and therapeutic uses it is unsafe and unjust-

ifiable to attempt to force fluids beyond the ileocecal valve. There is no gainsaying such a positive statement from such a careful observer and eminent author as Professor Senn, and I would sum up by saying that my belief is that the valve of Bauhin is impassable to fluids from below, that any attempt to overcome its integrity would necessitate the employment of force that would, beyond the peradventure of a doubt, materially injure the intestinal structure, and that any how it would seem as if two quarts of fluid were rather a small amount to irrigate the tube in almost its entire length.

Hare and Martin, basing their opinion on experiments made by themselves during the past two or three years, coincide with Cantani in his conclusions, and acknowledge his claims. Hare insists on the following requirements receiving due attention in performing the operation: Give the injection slowly and with great care, never use a pumping syringe but let the fluid be forced onwards by gravity, always therefore use a fountain syringe: to fill the colon use a pressure of from one to two pounds, and to force the injection into the small intestine do not allow the pressure to pass above six pounds. As a rule twenty minutes suffices for the operation, but if after forty-five minutes of gentle but constant pressure, the valve has not been opened, it is advisable to stop, at least for the time being.

But in spite of the difficulties that we have so far met with in our endeavors to put into practice a theory that is in every way correct, we are not disheartened, and I believe that in the near future we

will be enabled to perfect some such a plan. Dr. Senn assures me that he believes the intelligent and scientific mode of treatment of cholera, to be the early disinfection of the intestinal tract with some gas inimical to the cholera spirillum. He advises me that chlorine gas would probably meet the requirements. Further experimentation will have to be made before we can decide as to the amount of this gas to be used, and exactly how it is to be employed. With respect to the irritating properties of chlorine, I would remark that since Shurley has introduced it into the intrapulmonary cavity, which is lined by a mucous membrane very sensitive and antagonistic to it, I believe it to be feasible to introduce this gas into the intestinal cavity. Perhaps hydrogen would be indicated, as so far as I know the microbe of tetanus is the only pathogenic micro-organism that can live and develop in this gas.

But at this point, and with good reason, you ask me: "Can we disinfect in any way both large and small intestine? Can we pass the boundary line that is guarded by the colic valve?" In answer, I would refer you to the results of a large number of experiments made by Dr. Senn with regards to rectal insufflation of hydrogen gas, as a test in the diagnosis of visceral injury of the gastro-intestinal canal in penetrating wounds of the abdomen. After careful and painstaking observation, Senn makes the following deductions:

The entire alimentary canal is permeable to rectal insufflation of air or gas.

The ileo-cecal valve is rendered incompetent and

permeable by rectal insufflation of air or gas under a pressure varying from one-fourth of a pound to two pounds.

Air or gas can be forced through the whole alimentary canal from anus to mouth, under a pressure varying from one-third of a pound to two pounds and a half.

Rectal insufflation of air or gas to be both safe and effective must be done very slowly and without interruptions. Therefore inflate slowly, as long continued, uninterrupted pressure accomplishes most effectually lateral and longitudinal dilatation of the cecum, conditions which render the ileo-cecal valve incompetent, and which must be secured before inflation of the small intestines is possible.

The safest and most effective rectal insufflator is a rubber balloon large enough to hold sixteen quarts of air or gas. The filled balloon is to be connected by means of a rubber tube with the rectal tip of an ordinary syringe, and between the tip and the balloon, there should be a stop-cock, so that the escape of gas can be prevented whenever necessary. The return of gas along the sides of the rectal tip can be readily prevented by an assistant pressing the anal margins firmly against it.

The entrance of gas from the colon into the ileum is always attended by a diminution of pressure, and its occurrence can invariably be recognized by gurgling or bubbling sounds heard over the ileo-cecal valve, and sometimes the sounds are sufficiently loud to be appreciated at some distance.

The resisting power of the intestinal wall is nearly

the same throughout the entire length of the canal, and in a normal condition yields to diastaltic force of from eight to twelve pounds of pressure. When rupture takes place it either occurs as a longitudinal laceration of the peritoneum on the convex surface of the bowel, or as multiple ruptures from within outwards at the mesenteric attachment. The former result follows rapid, and the latter slow, inflation.

Dr. G. C. Purvis suggests the employment of a solution of sulphur dioxide by rectal injection, as in Cantani's method of tannin enteroklysis, to destroy the cholera germ, in those portions of the intestinal tube reached by the solution of the gas. The sulphur dioxide may be prepared by acting on crystalline sodium sulphate by either hydrochloric acid or sulphuric acid, in water that has been boiled.

Surgeon-Major Brown, U. S. A., speaks highly of the rectal injection of solution of hydrogen peroxide, in the proportion of two teaspoonsful to a quart of hot water, but I need not call to your mind reasons why these procedures would have the same objections offered to their use, as we have advanced against Cantani's. Brown recommends the hypodermic injection into the abdominal wall of the whole of the following formula: Sulphate of strychnine, about one-sixteenth of a grain; sulphate of morphine, about one-third of a grain; ergotine of Yvon-Sick, about five grains; and distilled water about one teaspoonful. This injection to be repeated in an hour. In succeeding injections the strychnine to be omitted, and the morphine also if there be the slightest signs

of narcotism. Half hourly doses of the ergotin, may be given, and if the diarrhea does not improve, larger quantities may be exhibited.

I would suggest the administration of an "enteric" pill of inspissated and purified bile, or the conjugate acids, at regular intervals of time.

The very latest reagent proposed for attacking the cholera spirilla in the intestine, is ammonio-tetrasulphate of potassium, which is endowed with the remarkable property of remaining neutral in reaction at ordinary temperatures, but resolving itself into an acid sulphate at blood heat. It is claimed, with what truth I can not say, that this drug, when taken with food, remains neutral in the stomach, but gives off its acid combination in the intestine. The powder is odorless and tasteless and a dose of ninety grains is reported as having been well borne by a dog. In theory this is all right, but we will have to await practical tests, before deciding as to practical results.

Hare quoting Harkin and Groneman, speaks of the extraordinary results produced by the application of blisters over the pneumogastric nerve in the neck, a therapeutic measure to which I simply refer.

Some little time ago, I told you of the hydrotherapeutic *régime* recommended by Winternitz in connection with prophylaxis. With even more confidence, this observer advises hydrotherapy in the first stage of the malady. He declares the action of this treatment to be, that through thermic irritation a stronger contraction of the intestinal blood vessels is produced and greater resistance is thereby afforded to the trans-

udation of fluids. The results to be expected are: Peristaltic movement is slowed, the excretion into the intestine is diminished, and absorption is increased. Winternitz holds that by his methods the peripheral circulation is enlarged and accelerated, the nervous system is aroused to meet the requirements of the body, and the patient's vitality is given an impetus to activity. The simplest method by which these results are to be attained, the one most easily carried out anywhere, and without exception the most effective is an energetic rubbing off of the patient's body with towels wrung out in ice-cold water, followed at once without the patient being dried, by a sitz-bath at from 43.3° to 51.6° C. (110° to 125° F.), lasting from fifteen or twenty, to thirty minutes, according to effect produced. In this sitz-bath all of the patient's body not immersed in the water, must be covered by a blanket. Should the patient be strong enough he must be required to energetically rub his belly with his hands; if not, two nurses should kneel beside him, one on either side, and reaching under the cover, rub his abdomen. After the bath the patient is to be wrapped up in a hot dry blanket, put to bed, and his extremities well rubbed beneath the covers. In place of these procedures, a sharp sprinkling of cold water, or a movable fan douche directed against the abdomen for from half a minute to a minute and a half, followed by the sitz-bath, will fulfil the indications very well. The treatment is usually succeeded by a complete reaction, and the patient breaks out in a profuse, grateful perspiration.

Fullerton, of Columbus, Ohio, speaks in terms of

praise concerning the exhibition of quinine. He suggests that one drachm of the drug be dissolved in three ounces of water by means of sufficient aromatic sulphuric acid, and that of this solution a table-spoonful should be administered and at once repeated should vomiting occur, and afterwards at intervals of an hour and half until thirty grains have been taken, and thereafter *pro re nata*.

For the muscular cramps, should they persist after the exhibition of camphor and salol, or the use of the bath, you had better exhibit morphine hypodermatically, as occasion may require. If the vomiting be present, the patient may be given "ice-pills," small pieces of cracked ice which he should swallow whole and not allow to melt in the mouth, cold champagne, seltzer or carbonic-acid water. Wine of ipecac given in drop doses, and oxalate of cerium in doses of from one to three grains, are recommended, but the drug that I place the most reliance on in controlling vomiting from any cause whatever, is glonoin. A nitro-glycerine pellet of the one-hundred and fiftieth of a grain, repeated as occasion may demand, is a very potent remedial agent. Of the anti-emetics, Bucquoy places the greatest value on menthol, while in combating the vomiting Laussedat uses a mixture composed of seventy-five minims of ethereal tincture of valerian; fifteen minims of Sydenham's laudanum; five minims of essence of peppermint and seventy-five minims of Hoffman's anodyne. Of this the patient is to receive twenty-five drops every few minutes until the tendency to vomit is relieved. In this period Hare states that the following prescription is

very efficacious: Half an ounce of aromatic sulphuric acid; fifteen drops of cajuput oil; two drachms of fluid extract of hematoxylin; one drachm of spirits of chloroform; and three ounces of syrup of ginger. Of this a teaspoonful is to be given in water every two hours. To the question as to whether the patient is to be allowed to quench his thirst, I would unhesitatingly answer, yes. Let him drink plain water, previously boiled, then placed in a bottle and put on ice. Claret, or small quantities of brandy or whiskey, or vermouth, or Rhine wine may be added to the water with excellent effect. Do not allow the patient to drink much at a time. Give him small quantities at a dose frequently repeated. A tablespoonful of fluid given every ten or fifteen minutes, is much better for him than larger amounts, at longer intervals. Cold tea and coffee are often relished, but while cold drinks are as a rule craved, you will frequently find that hot drinks will be better borne and productive of better results. Before leaving this portion of our subject, I would say that too much stress can not be laid on the general management of the case. As soon as the diarrhea manifests itself the patient should be ordered to cease immediately his work, and lie down in bed between blankets. For several hours he should eat nothing, and a flannel bandage should be applied over the abdomen. About eight or nine hours after the subsidence of the diarrhea he may be allowed egg-white, mucilaginous drinks, scalded toast, gruels, wine-whey, arrowroot, farina or rice. Beef-tea, soup and all meat broths must be excluded from the bill-of-fare. After recovery, for

several days the patient must be very conservative, and gradually return to his usual vocation and normal diet.

LECTURE VIII.

At my last lecture I outlined to you the treatment of the first stage of cholera; and of the plans suggested, I would recommend the internal exhibition of salol and wine of camphor, the giving of acidulated drinks, the administration of small quantities of various liquids as occasion requires at short intervals of time, the careful and intelligent application of Winternitz's hydrotherapeutic measures, and the early performance of Senn's operation of gaseous intestinal disinfection.* As an initial step, I would give a cholagogue, followed by a dose of castor-oil, and then check any subsequent diarrhea. If muscular cramps persisted I would use morphine hypodermatically. If there was much abdominal pain, I would use hot applications over the belly, and I would have you understand now, that I condemn in a most unqualified manner, the routine use of opium. When this drug of necessity must be used, the denarcotized opium or the deodorized laudanum, preferably in acidulated solution, ought to be employed. Hare's ruling in this connection should be followed; never use opium, in cholera, to arrest diarrhea, but exhibit it only to diminish pain. At the risk of being considered tautological, I will repeat that you must watch your patient very carefully during the first stage, remembering that the onset of the second stage

*In the near future a report will be made giving positive details as to this mode of treatment. As yet it is too early to be specific about details. The question is one that requires further investigation.

is excessively rapid and that your treatment in this initial stage must be largely expectant. If, therefore, your patient does not soon improve, if the diarrhea persists, I would begin quickly to take measures to head off the cholera asphyxia. I think that here Winternitz's or Semmola's hydrotherapeusis is excellent treatment, and I would not delay, but would take advantage of the acceptable time before the hour of salvation had passed. If vomiting continues, I would rely largely on the use of nitro-glycerine to control it. I have seen severe, uncontrollable, incessant attacks of vomiting completely subjugated by from two to three doses of a hundred-and-fiftieth of a grain of this drug, given per orem at intervals of **from half-an-hour to an hour.**

If the first stage continues, you must bear in mind what is going on in the interior of your patient's body:—The bacilli are growing and multiplying enormously in the bowel, the toxic materials are being elaborated, are being absorbed, are coursing in the blood, and ultimately will reach the various tissues of the economy. The blood is being drained of its water and the soluble, diffusible matters therein dissolved; this is thickening the blood, decreasing its volume, and will in the end change it into a viscid, almost grumous liquid that can scarcely be forced through the smaller blood vessels. We have seen that we can reach and attack the cholera germ in the intestinal cavity, and if we succeed in devitalizing it there, we have done our full duty in this regard, for the germ is not found in the body outside of this location; we have seen that we can reach the toxines

in the intestine, but we know that these poisons pass into the blood and tissues. Therefore we ask, can we neutralize them after they have left the bowel? When they have reached the tissues? While still in the blood?

In answer to this, I would say that it is impossible to stop the action of these noxa if once taken up in the system in doses large enough to interfere with the central functions.

We can, peradventure, keep up the strength of our patient with stimulants and proper nourishment; we can excite or arouse nervous activity; but if the amount of virus be but sufficient, our endeavors will very soon be of little service.

But now you ask me: can we interfere with the poison while yet in the blood stream? So far we know nothing positive concerning such treatment. Prophylactic inoculations with this end in view, have been proposed; but the results are very doubtful and irregular.

Ciaramelli, in 1885, reported magnificent results in treating cholera by hypodermic injections of the citrate of iron, in the stage of collapse. His method was to inject three times a day a syringeful of a ten or twelve per cent. solution of this salt, representing three grains of iron, and his results in all probability were due to the action of the acid component of the iron salt on the absorbed poisons.

Maestre's treatment of cholera collapse with chloral injections, seems to be valuable, according to report. In this case again in all probability we are dealing with a neutralizing of the cadaverin, when

we are told that chloral in the blood is changed into an acid product, afterwards visible in the urine as uro-chloralic acid, and later as glycuronic acid.

You recollect that one of the conditions I have laid stress upon in the disease we are considering, is the absence of absorptive power during the algid stage; you remember I have warned you how dangerous it is, and how useless, to pour drugs into the digestive tract of an individual at this time, and I would now advise you to bear in mind, that the exhibition of medicinal agents by the mouth, is therefore, only correct while intestinal absorption lasts. Whenever, during cholera asphyxia, drugs are positively and quickly required, hypodermatic administration affords a much better chance of effective action than swallowing, even although the absorptive functions of the subcutaneous connective tissue are reduced or suspended by desiccation and shrinking during collapse.

When the algid stage is feared, but has not as yet arrived, Semmola's plan of administering repeated hot baths (from 100° to 104° F.) I imagine would be efficacious. It is useless to wait for collapse to set in, for then the hot bath would have but little more effect than with a corpse. This authority describes the bath as having a calmative effect and a pronounced rallying influence.

In incipient collapse, Dr. J. C. Peters recommends the use of pieces of unslacked lime, wrapped in wet cloths and put in bowls around the patient's body, under the bed-clothing. The heat so produced is very gratifying. Packing the patient in blankets

wrung out in hot cayenne or mustard water is useful; and as the blankets become cool or dry, hot water may be poured upon them, without disturbing the sick man. Sinapisms applied to the abdomen, and hot flaxseed poultices with a little mustard mixed with the meal are grateful.

Wendt, in his excellent treatise on cholera, describes how an energetic doctor once gave his collapse patients a hot bath, made them drink all the hot water their stomachs would hold, and then pumped not only their bowels but their bladder full of hot water, and complacently said if any one could do more to warm a patient up he would like to hear of it.

Maclean, Macnamara, Parrot, Hartshorne, Desprez, and Wendt all speak favorably of the use of chloroform both internally and by inhalation. Desprez claims that by its use from eighty to ninety out of every hundred persons in the algid stage can be saved. His formula is:

R	Chloroform	15 minims
	Alcohol	2 drachms
	Syrup of hydrochlorate of morphia	1 ounce
	Acetate of ammonia	2 drachms
	Distilled water	3 ounces

Misce et signa:—A tablespoonful every half hour.

Chloric ether is valuable given hypodermatically, and T. French-Mullen states that he has given in the same manner strychnine in some hundreds of cases of cholera, with very satisfactory results. He uses the method in every case in which collapse has set in or seems to be coming on. He gives five minims of liquor strychniæ in an equal quantity of

water. As his patients were almost all seen in their own homes, and there were so many to be visited, it was as a rule, only possible to give two injections in the day (morning and evening) to any one case. He has, however, given five injections in twenty-four hours, and two more during the following twelve hours in the case of a prisoner where the effects could be watched, and has no doubt the man owed his recovery to the remedy.* When the urinary secretion has not been re-established within twelve hours or so of the cessation of the other symptoms, hypodermic injections of pilocarpine have produced excellent results. In many cases urine appeared within less than five minutes after the use of the syringe. A symptom that sometime becomes very distressing is singultus or hiccough. It can usually be arrested by a hypodermic injection of morphine, an epigastric sinapism, or a blister. Should these means fail, it may be necessary to give a few whiffs of chloroform.

I do not wish to have you understand me as advising you to withhold all fluids from your patient in the second stage. Stimulants may be given, Burgundy or Tokey wine, port or sherry wine, brandy and soda water, or champagne. The ammoniacal preparations, and camphor and musk, may be used, but, as previously remarked, when the algid stage once becomes pronounced in spite of attention, to continue giving medicine by the mouth is worse than useless. In mild cases you will find that hot water

*Dr. Chauncey F. Chapman informs me that in certain cases he has exhibited without untoward effects, one-twelfth of a grain of strychnine, eight times in the course of a single day. The patient being all the time under observation.

bottles applied around the body, sinapisms, hot drinks, and so forth, will do; if not, you must not procrastinate, but adopt some more energetic measures, and one of the best measures for ordinary use, is the one proposed by Dr. Peters, and which has been detailed to you.

In addition to the various pathological conditions that we have been endeavoring to obviate, there is a group to which I now direct your observation; comprising the thickening of the blood, the decrease in its volume, the drying up or desiccation of the tissues and the pretty general arrest of secretion, that of the kidneys being the most important. These conditions are in the main due to the enormous and rapid drain that is made on the system by the colliquative intestinal discharges. Our first indication is to prevent the loss of water, but failing in this we must try and make good the loss. We can accomplish this latter end by intravenous and subcutaneous transfusion of fluids, resembling to a certain extent, the physiological plasma sanguinis.*

This brings us to the study of hypodermoklysis, a procedure introduced by Cantani, and first used in cholera by Oser.

As its name indicates, this operation consists in the injection of fluid under the skin, in order to flush the system. About three or four years ago Dastre

*Dr. C. Barth suggests that the absorbent surface of the mucous membrane of the bladder should be utilized for the introduction of water into the anhydremic cholera system. According to this observer, the scanty concentrated urine found in the bladder after death in cholera seems to indicate the reabsorption of urinary water, under the influence of the increased density of the blood in the vessels. Copious injections of saline fluid into the urinary bladder may therefore aid in fulfilling the main indication of the choleraic state.

and Love in experimenting on dogs and rabbits, injected a seven-tenth per cent. solution of chloride of sodium directly into the animals' veins. They found that they could without any danger to the life of the animal, transfuse in this manner four times the amount of the normal quantity of the blood.

A remarkable fact noticed by these observers was that the blood tension, which could reasonably be expected, on account of the plethora induced by the operation, to be much elevated, was no higher than before.

Again, they noticed that about two or three hours after the operation a well-marked diuresis was induced. Continuing their studies, they ultimately fixed the unit of transfusional capacity which they found to be a flow of one drachm of the solution into the blood current, in fifteen minutes, for a pound weight of the animal's body. Thus for an ordinary dog, weighing about twenty pounds, the maximum harmless quantity of salt water infused into his system would be about two drachms per minute, and if this ratio were kept up, the operation might last for hours, with the result that a balance would be struck, just as much fluid flowing out of the system, in a given space of time, as was poured in. If however the rate of speed of the inflowing current, was increased over and above that which kept up the condition of equilibrium, then, fluid would accumulate in the system, and produce a fatal result, because the kidneys would not be able to remove the fluid as fast as it was injected.

During the time that the infusion is going on, it is

noticed that the urine of the animal becomes paler and paler, losing in specific gravity, until at last it becomes very similar to the fluid injected. In this way there is induced a flushing out, or washing of the body tissues, and very much more urine is passed than would have been possible without the injection. Albumen does not appear as a result. This operation is safe only with an absolutely healthy heart, for in a diseased organ the increase in tension of the fluid in the right heart, might prove serious.

On the other hand, Roux and Yersin have not obtained good results with this mode of treating animals poisoned with different bacterial products. The operation was considered for various reasons dangerous as applied to man, and methods were sought for that would produce its beneficial effects and obviate its dangers.

Such a method was discovered by Cantani, who first conceived the idea of injecting the physiological solution hypodermatically, and who named the operation "hypodermoklysis." He recommended it in two different conditions: post-hemorrhagic exhaustion, and in cholera; although to Oser, by some is given the credit of first adopting the procedure in the latter condition. Cantani's purpose was to overcome the desiccation of the tissues, by replacing the water that had been removed. But he builded even better than he knew, and more advantages are now claimed for the operation, than were ascribed to it by its discoverer. We recognize today that many diseases are caused either by materials resulting from metabolic processes connected with microbic life in

our bodies; or, are induced by the physiological waste-matters of the body itself. The investigations of Brieger and of Vaughn leave no doubt but that in both instances there appear varieties of highly poisonous substances, which are either alkaloidal, produced by decompositions and called ptomaines or toxines; or, are derivatives of pathogenic bacteria, and called toxalbumines. Now when these bodies are introduced into or retained in the circulation, they produce deleterious effects, which are known as "intoxications." It has been proven, that, in various diseased conditions especially those accompanied by a febrile movement, these noxa circulating in the blood stream, are removed from the economy largely by the kidneys; and it is a well-recognized clinical fact that in these infectious diseases, the reappearance of a copious flow of urine is a most favorable sign. Now by the method we are describing if there have not been pre-existent renal disease such a flow can be established, and the poisonous matter washed out of the system.

The technique necessary for the performance of hypodermoklysis, is comparatively simple. A glass vessel, containing about thirty to forty ounces, is filled with a sterilized solution of seven parts of sodium chloride, and one-thousand parts of water (about three and one half grains to the ounce). The temperature should be in the neighborhood of 43° C. (110° F.). Leading through a tight stopper from the vessel to an india rubber tube which is to be attached to a large-sized canula, there is a glass syphon; while leading to the bottom of the vessel for the purpose

of admitting the necessary air, is a glass pipe, filled at the upper end with sterilized cotton. It is hardly necessary for me to remark that every part of the apparatus should be absolutely sterilized. The best place for administering the injection, is in the abdomen. The trocar is to be pushed through the skin into the subcutaneous connective tissue, then withdrawn, the tube connected to the canula and the fluid injected by holding the glass vessel about four or five feet above the patient's abdomen. The time required for infusing thirty ounces is about five minutes. While the fluid is flowing a tumor is slowly formed, which is gradually absorbed in about three hours and which may be slowly and carefully kneaded by the fingers of one hand during formation. While it is a fact that this tumor is painful, yet it disappears in from two to three hours, and its discomfort can be reduced by making two injections, one on either side.

During the operation hold the canula parallel with the surface of the body, or rather incline its point a very little toward the skin. While the fluid is flowing in, the canula should be pressed slowly forward, in order to distribute the solution in a greater space, and to prevent its regurgitating outward from the point of entrance. After the withdrawal of the canula, the puncture is to be immediately closed with rubber plaster. It is not unlikely that in a considerable number of cases an abscess will follow, but this need not cause any alarm.

In private practice the apparatus required need not be as complicated as I have described. In a

clean tea-kettle, boil a measured amount of water, for from ten to fifteen minutes. Towards the end of this time, shake in some table salt in the proportion of one heaping teaspoonful to a quart of water. Allow the water in the kettle to cool to the proper temperature point, place it on a step-ladder, or hang it at the correct height, attach one end of a disinfected or sterilized rubber tube to the kettle nozzle, and the other end to a canula which has been pushed into the areolar tissue beneath the skin, and the trocar pulled out.

Samuel's continued subcutaneous infusion, as performed by Kutner, is somewhat different as regards technique. Kutner operates in the infraclavicular fossa, on each side alternately, and eventually in the supraclavicular fossa. He stops the inflow, or retards the ingoing current very materially, if absorption be slow. He injects continuously during the whole duration of the stage of asphyxia, to deep in the typhoid period, even after the secretion of urine has recommenced.

Keppler advises an injection at first on both sides, of fifteen and one-half fluid drachms; as soon as this is absorbed (about one minute), thirteen and one-half drachms more, and so on until the pulse improves. When a swelling forms, its disappearance is awaited. As soon as the pulse shows improvement, five minutes are allowed to lapse between injections; when the pulse becomes full, intermissions of thirty minutes, are permitted. Keppler stops the injection as soon as renal activity is made manifest, but repeats it at once on the occurrence of a new attack. He

uses usually from eight to twelve quarts of fluid, which is a solution of common salt in the proportion of one drachm to the quart, at a temperature of from 102° to 104° F. He uses several canulas, leaving each canula *in situ* even after the infusion at that point is, for the time being, completed. Neumann recommends the addition to the salt solution, of one-tenth of one per cent. of sodium carbonate.

In desperate or well-nigh hopeless cases, Hayem's intravenous transfusion may be performed, a much more difficult and dangerous operation than hypodermoklysis; but one whose action is often instantaneous. The fluid is a sterilized solution composed of one and one-quarter drachms of common salt; thirty-four ounces of distilled water; and enough sulphate of sodium added to increase the solid matter to six and one-half drachms to the quart. The operation is performed with a Collins' transfuser, and two to two-and-one-half quarts are injected in a quarter of an hour. Should the pulse again become thready, then a second injection follows ten to twelve hours after the first.

The injection fluid is drawn from the funnel of the transfuser into the pump, and from the pump into the tube. The distributing chamber of the transfuser is a cylinder, which communicates through three openings with the funnel. It contains a round ball of aluminum, whose specific gravity is arranged so that it will be less than that of the solution to be injected. In this way it serves as a valve, and prevents the fluid from flowing back into the funnel, or air from entering the veins.

The effect of either hypodermoklysis or intravenous transfusion, in some cases, is simply marvelous. Where, only a few moments previously, circulation and respiration had ceased, and where hope was lost, a striking change will be noticeable, and an abrupt and deep inspiration indicates a return to life. In other cases the benefits are appreciated much more slowly and are sometimes initiated by increased kidney activity. Vanderpoel describes the case of a man, who after passing through all the routine of treatment, was left to breathe his last, resembling a terribly emaciated corpse. He then had a quart of bicarbonate of soda solution thrown into his veins at the bend of the arm. It was strange to see him revive from an immovable, shrunken, death-like condition, the veins on his nose becoming filled, the skin reddening and expanding, then his limbs beginning to move, and he to survive.*

Cantani's summing up with regard to the value of hypodermoklysis, is as follows:

The hypodermic injection is an invaluable therapeutic remedy in the treatment of cholera.

*Dr. Silbermann, whilst recognizing the value of subcutaneous and intravenous injections of saline fluids in cholera, points out that owing to stagnation of the thickened blood in the venous system, it may be far better sometimes to inject the fluid into the arterial system in a manner similar to the form of arterial transfusion introduced by Landors and Ungar. The radial artery is laid bare for a short distance, the peripheral end of the exposed artery secured by a ligature and the central by the forceps. The apparatus consists of a funnel-shaped receiver of from five to six hundred cubic centimetres' capacity, terminating in a T shaped tube with which is connected a syringe, the vertical limb being attached to the rubber tube which ends in the nozzle that is afterwards inserted into the artery above the point of ligature. This insertion does not take place until the tube and syringe have been filled with fluid and all the air driven out. The fluid is then pumped into the artery *toward* the heart, by means of the syringe; and the process of filling the syringe and repeating the injection is readily effected without any risk.

In order to be of value it must take place under conditions which render absorption possible. In order to obtain these it should immediately follow a warm mustard bath of about 40° C. (104° F.).

The hypodermic injection, as an absolutely harmless remedy, should be put in use as soon as the case of cholera comes to the physician's notice, and should be methodically repeated every four hours.

To further the absorption, it is well to apply the injection at several, or at least, at two places.

The hypodermic injection is not to be regarded as an exclusive remedy for cholera, but it can remove the symptoms accompanying the disturbances in circulation, and following this the imperfect formation of the blood.

During the later periods of the Hamburg epidemic, the per-iodates were used with, it is stated, marked advantage and noticeable decrease in the mortality.

At the Seamen's Hospital, the following plan is carried out: There are two principal drugs employed – the crystals of per-iodate, which are powdered, and a per-iodate of iron. The last named is used in such cases as demand an extra strong nerve or cardiac stimulant, and where there are severe neuralgic symptoms. The first named is used in several ways. First, as a powder to disinfect the alimentary tract. Second, as a plain water solution, prepared by boiling, and used by patients as a beverage to wash out the stomach in severe vomiting, which abates as soon as the walls of the stomach begin to absorb the fluid, whereby the nervous energy is stimulated in from a few minutes to an hour or two; it is used for hypoder-

mic transfusion, and in cases of collapse for intra-venous injection for restoration of the suspended circulation of the blood. Third, an acid solution of the powdered crystals of much greater strength than the plain water solution is found to stimulate the liver and kidneys and gall bladder, promoting a free flow of bile. The effect of this treatment in cholera is alleged to be very marked and speedy. In a case of collapse with all the severest symptoms present, the patient is placed upon the bed and copious draughts of per-iodate are given and repeated until a sufficient quantity is retained. Meanwhile the transfusion solutions are ready in the hot water bath, and usually within five to ten minutes, one to two quarts are run under the skin by a double canula. In about fifteen minutes the fluid is absorbed into the tissues and passes into the circulation, which is thereby restored, and the pulse and the heart beats return. In some cases the fluid is run direct into a vein, usually of the arm, but where this is so far contracted as not to admit of the smallest canula, a vein of the thigh is opened. But even the larger veins will sometimes not receive the instrument, and such cases are hopeless.

Recently Mr. Weaver gave a demonstration of the chemical and physiological actions of the per-iodates before the hospital staff and several visitors, including Dr. Cornel, Prof. Koch's confidential assistant, and a well known bacteriologist. During the lecture several severe cases were admitted into the ward, practical illustrations were given of the method of physiological examination of new patients and of

those who had been under treatment for some days. From the new patients Dr. Cornel showed the presence of swarms of cholera bacilli possessed of intensely active movements when shown under a glass magnifying 1000 diameters. From the patients who had been under treatment, neither toxines nor bacilli were obtained. From the experience gained in the treatment of cholera, Mr. Weaver¹ is of the opinion that the cure of the disease necessarily implies its **prevention by the same means.**

In closing this portion of our subject, it might not be out of place for me to indicate to you what particular plan of treatment I look upon as being best. But in outlining the form of management that appeals to me the most forcibly, I would first warn you against becoming *routinists*. Every case you have may demand some special attention, and a good general rule to be remembered, is, that every case of a given disease, must be treated on its own merits. But to resume: Should I be attacked by Asiatic cholera, I would, as soon as the first symptoms declared themselves, take to my bed. I would follow Olliffe's suggestion, and immediately take a chologogue, either blue mass or calomel, and repeat in two hours or until some green appeared in the stools. I would then take from one to two drachms of castor oil, and if required would repeat this dose in about an hour. I would subject myself to Winternitz's hydrotherapeutic measures, from the very first I would use full doses of salol and wine of camphor, every now and then would drink a small quantity of a mixture of equal parts of red-wine and water, and at short intervals of

time, I would take a little water acidulated with sulphuric or lactic acid. I would insist on my attendants resorting, at once, to the careful and thorough performance of Senn's gaseous intestinal insufflation, and unless improvement was quickly evidenced, I would begin the use of Desprez's chloroform mixture, and perhaps hypodermic injections of chloric ether. Should there be early symptoms of cardiac element, I would request the hypodermatic exhibition of strychnine, and if muscular cramps and pain were marked, the injection of morphine. I would beg my attendants to surround me in bed with bowls containing unslacked lime wrapped up in wet cloths, and if amelioration were not rapid, to administer a hot bath, with concomitant massage and rubbing of my body with a flesh brush. Then I would ask to be put to bed, wrapped up in a hot dry blanket, and have a good sized sinapism applied to my abdomen. Should pronounced purging thicken my blood I would demand the employment of hypodermoklysis of normal salt solution, and should all efforts prove unavailing, I would at least feel as if the evil genius of the White Death had, in me, met a foe man worthy of his steel, and one who had not succumbed until overpowered by superior strength. And I would further ask that after my death had been positively assured, my body should be securely and quickly covered with a sheet soaked in a disinfectant solution, and as soon as possible, cremated, so that I, who had in life been a friend to humanity, should not after my death, become a foe.

LECTURE IX.

There remains yet for consideration the question of the treatment of the stage of reaction of cholera, and the condition known as cholera-typhoid. If your patient rallies from his collapsed state and enters upon the reactionary period, not by any means is he yet out of danger. You must still consider his condition critical, and pay him attention. You must also remember that relapses not infrequently occur, and when such an accident takes place, you will treat it with the same caution and on the same principles as the primary attack. When you recollect that the fury of the storm has been largely spent on the gastro-intestinal tract, you will appreciate the necessity for the strictest supervision of the patient's diet. It is during this period of reaction, that we recognize the value of good nursing and diet. Drugs are of but little if any value, and the sick man is better off without medication. Solid food-stuffs are absolutely dangerous. If you have studied carefully the morbid anatomy of the disease, you will appreciate how cruel it would be to subject the tender, ulcerated and inflamed bowel to the effects of the ingestion of solid food. Fluid nourishment however should be freely given. Milk, at first diluted with plain or preferably with carbonic acid or seltzer water, egg-white, gruels, wine-whey, sago, rice, or arrowroot decoction, well seasoned and strained, constitute a pretty good slop bill of fare. Coffee, tea and chocolate or cocoa may be gradually added, although coffee is well borne

nearly all through the disease. This is the time when wines are of great benefit, and small quantities of rich, generous wines, given often are advantageous. Broths and soups should not be allowed early, but their use must be deferred. Very excellent authority has advised me that often in this stage, a patient will be progressing in a very favorable manner, when the exhibition of some broth or soup, has been followed by a diarrhea. Gradually a diet made up of soft-boiled eggs, soups, broths, bread, potatoes, and meats can be resumed. In a majority of instances the kidneys will need some attention. Plenty of clean, pure drinking-water will stimulate them sufficiently in mild cases.

In the first variety of cholera-typhoid the treatment should be identical with that belonging to the third week of enteric fever. The patient should be in a well ventilated room, kept in the prone position, not allowed to sit up or make any exertion, and maintained on liquid diet. Naturally milk is the most suitable food. At least three pints should be given to a grown person during the twenty-four hours, always somewhat diluted as previously described. Partially peptonized milk is serviceable, but it tastes so badly, that as a rule the patient will object to it. The general treatment described for the stage of reaction, is here applicable. The patient should be encouraged to drink freely and the fluids given him, may be pleasantly cold. Iced tea, barley water and lemonade are grateful. Sponging the body off with alcohol or whiskey, once or twice a day, is productive of good results. There is no

necessity of reviewing in its entirety the treatment of this condition. It suffices to draw a comparison between it and the management of the period in enteric fever, to which I have already drawn your attention.

The second form of cholera-typhoid is the condition wherein we find the most diverse complications. We may have dysentery, or a violent inflammation of a diphtheritic character of the large and small intestine, or pneumonitis or pleuritis or laryngitis, and so forth. Your treatment will have to be symptomatic, but you will bear in mind that in addition to any of the symptoms, or groupings of the same, that may characterize this condition, there may also be intestinal and renal lesions of considerable intensity. You will recollect that these people are very apt if they do recover, to suffer from troublesome sequelæ.

The third variety of cholera-typhoid that you may have to treat, is the uremic type, the most severe of all. Here we find the symptoms of a severe nephritis. You will rarely if ever, meet with anasarca in these cases, but you know a most intense inflammation of the kidneys may exist without any dropsy. The rules as regards diet and the use of diluent drinks previously given, apply all the more forcibly to this class of patients. Where there are pains in the back and hematuria, dry cups followed by hot poultices are grateful and relieving. The wet pack or hot-vapor bath are measures that are indicated. The wet pack is given by wringing a blanket out in hot water, wrapping the patient up in it, covering

this with a dry blanket and the whole with a rubber cloth. In this the individual may remain for a longer or shorter period of time, according to the effect produced, and while in the pack, he should be watched. The hot air or vapor bath may be given by allowing the heated air or vapor to pass from a funnel beneath the bed clothing, which is raised on a low scaffolding. If the patient is able to bear it, an excellent treatment is a hot water bath, of from ten to twenty minutes, after which he is immediately to be wrapped up in blankets. A portable bath (as shown in the appendix) should be brought close to the bed, so as to cause the least possible disturbance to the patient. Very profuse sweating can usually be produced by some of these procedures, and they are very rarely exhausting. Sometimes, however, the skin will not react, sweating can not be induced and then we must resort to medicinal reagents. Diuretics may be exhibited, or a sixth to an eighth of a grain of pilocarpine may be given hypodermatically. I must confess though that I am afraid of pilocarpine. On several occasions I have seen great depression following its exhibition, and on more than one instance a very distressing bronchorrhea. If anuria exists thirty-six hours after reaction has set in, Macnamara is in the habit of administering the tincture of cantharides. He gives ten minims in an ounce of water every half-hour until six doses have been taken. He then, if the treatment has not excited renal activity, discontinues the medicine for twelve hours, and repeats in precisely the same way, giving six doses more.

Following this plan, most satisfactory results have been reported.

Heart tonics, such as digitalis, strophanthus and strychnine should not be neglected.

I have now in a general way, outlined to you the treatment of Asiatic cholera, without having exhausted the literature of the subject, which is very voluminous. As the pest progresses in different sections of the world, if you will follow closely both the medical and secular press, you will notice the suggestion of innumerable remedies, many of which will be absolutely ridiculous. I desire now to call your attention for a short time to a most valuable and interesting portion of the study-subject-matter of the disease, and will review some of the work that has been done in connection with the transmission of the malady to the lower animals, and to their immunization from future attacks. I would ask you in these studies to note how perfectly the various subdivisions into which our art and science are divided, dovetail into each other. We have seen this in studying other infectious diseases—notably enteric fever, and we have noticed that there is a gradual evolution of development, or passage from the simpler forms to the more complex, of the subdivisions. Thus the clinician studies the symptomatology; the pathologist teaches us the damage to the economy; the therapeutician delves into the lore of treatment; and the bacteriologist demonstrates to us the causative factors. But the territory of each one of these workers, overlaps that of every other, and he who would endeavor to separate the ultimate object of

any one, from those of the others, would fall into error. As bacteriologists, I would require of you that you look not upon the human body as a large test-tube containing culture media for the growth and development of various microorganisms, and to be subjected to the same treatment as such media would receive in your laboratory. To do this would be as incorrect as to look upon the processes of nutrition as being identical with the chemical processes you note in your beaker jars, your retorts or filtration stands. The interdependence of these apparently different sections, and their fusion the one into the other, are well shown in connection with the study of cholera. Thus the bacteriologist having discovered the specific, exciting, etiological factor of the disease, introduces morbid material into the bodies of some of the lower animals, in order to reproduce the disease. At first he fails, and in endeavoring to discover the reason therefor, he notices that the germ is prevented from growth by the acid reaction of a secretion of the body. He has here noted an important fact connected with prevention and with treatment, and the bacteriologist, the therapeutician and the sanitarian become merged into one. Continuing his experiments, he finds that under certain circumstances animals are poison-proof, and a new field is opened up, that of immunization. There is no disease which has been as thoroughly mastered by bacteriology, as cholera, and it will be excessively instructive and interesting to watch the bombardment which the morbid citadel will receive in the near future, from the combined prophylactic engines of war.

The limited time at my disposal, will not allow me to give this matter the attention it deserves, and I can simply erect for you a scaffolding on which you will subsequently build the more pretentious superstructure. I will only outline the picture, you will put in the high-lights and the varied shadows.

After the discovery and study of the spirillum cholerae Asiaticae, it became a question as to whether the disease could be transmitted to the lower animals. At first the experiments made in this direction, were failures, but before long, Nicati and Rietsch, at Marseilles, reported that they had succeeded in producing in dogs and guinea-pigs, symptoms pretty nearly identical with those of cholera, by injecting cultivations of the comma-bacillus directly into the duodenum. Their experiments were repeated and their observations confirmed, by Koch and others in Europe, and subsequently similar experiments were performed in this country. These authorities found they could produce the malady in the lower animals by first tying the common bile duct, thus cutting off the hepatic secretion from admission into the bowel, and Koch demonstrated the inability of the germs to retain their vitality after passing the acid gastric juice, when given by the stomach. He therefore neutralized the gastric juice for about three hours by a suitable injection of carbonate of soda, and later injected spirilla in meat infusion. Of nineteen animals, only one sickened and died with symptoms corresponding to those produced when the injections were made directly into the duodenum—and this was an animal which a short

time previously, had suffered from an abortion, an accident that with the existence of lax abdominal walls, suggested the possibility of delayed peristalsis. In a subsequent series of experiments, aperistalsis was induced by the exhibition of opium, with the result that of thirty-five guinea-pigs infected by way of the stomach, thirty died of "choleriform" attacks.

From the observations of Ewald, it would seem as if it would be comparatively easy under ordinary circumstances for the human animal to be infected. We have already seen that the most frequent mode by which infection occurs in human beings is through drinking water; and we have also noticed that water introduced into the empty stomach does not excite gastric activity, and that the fluid does not become acid in reaction; under these circumstances you can easily appreciate that it is not difficult for the bacilli to reach the small intestine, in the full preservation of their maleficent integrity.

Attempts to render the body immune against disease, have been made from time immemorial, but they were weak and empirical until bacteriology and micro-biological chemistry showed the way clear to positive results. In the writings of a chronicler in the middle ages, we read: "Philosophers have often searched for a fluid of such power, that rubbed on the skin, or incorporated with the juices of the body, would render the one so treated, proof against all maladies."

It is incorrect to state that the history of attempts at immunization is co-eval with the history of bacteriology, for attempts in this connection have not only

been made, but accomplished while the science of bacteriology was yet in the womb of the future. I need only call to your minds the labors and discovery of the immortal Jenner. But a short time ago, Pasteur began his admirable work; in Berlin, Brieger, Kitasato and Wasserman have made researches indicating that some of the lower animals can be protected against inoculations that in control animals would cause cholera; while at Paris, M. Haffkine has been experimenting with and perfecting his cholera "vaccine," on almost the identical lines that Pasteur followed in securing the protection virus of rabies.

In *The British Medical Journal* for September 10th, 1892, you will find a most delectable article from the pen of Mr. E. H. Hankin, who submitted himself personally to Haffkine's operation of "cholera-vaccination," and who discourses most interestingly thereupon.

Brieger reports as to his method which originally depended on the breeding of cholera bacilli in a watery extract of an organ rich in cells, such as the thymus. All his researches were, he states, carried on with a "Massowah" original culture, and at first with a thymus extract, proceeding in the following manner: The bacilli were allowed to develop for twenty-four hours on the surface of the thymus extract; they were then warmed to 65° C. for fifteen minutes or to 80° C. for ten minutes. For twenty-four hours, they were left in a refrigerator, and then used on the animals that were to be subjected to the preparatory treatment. Guinea-pigs were exclusively made use of, and these creatures received four

cubic centimetres intraperitoneally for four successive days. The animals were then, but particularly after the primary injection, taken quite decidedly sick, but would be improved, if not entirely recovered, by the next day. Thermometric observations indicated during this time, very striking fluctuations. In slight cases, in from three to five hours, there would be a febrile movement reaching perhaps to 40° C. The normal temperature of these little animals lies between 38° and 39° C. If, on the other hand, severe symptoms set in, the temperature would fall for some hours, two or three degrees below the abscissa. By the next day the guinea-pigs would have returned to health, and further use of the injection would present the same effects, in however a much slighter degree.

At once after the last injection, or about four or five days after the first one, these animals possessed special resisting power sufficient to withstand the specific effects of the cholera spirilla, and in very truth, could take without bad or untoward symptoms, three times the amount which, in twelve or fifteen hours, would kill unprepared animals. Right after the injection of virulent cholera cultures, in the treated animals, the temperature rose above the normal, and then in the course of a few hours, fell from two to three degrees. On the other hand, the compared animals by this time were suffering from the toxic effects of the injection, were relaxed, laid on their sides, had frequent convulsions, and their temperature had fallen to 32° C. These animals died, while the prepared ones would recover by the following day.

The minimum quantity of the fluid requisite to produce the desired effect, is one cubic centimetre, injected each day for two days, in a guinea-pig weighing between three and four hundred grams.

A much simpler mode of preparation has been suggested by Koch, which consists in breeding the bacilli in peptonized meat-broth and then heating the cultures on the next day for fifteen minutes to 65° C. Animals protected with this fluid have withstood a dose of poisonous cholera culture, half of which would kill the control animal. The minimum dose capable of exerting protective effect in this case was also two cubic-centimetres, and the protection followed in forty-eight hours after the first injection, lasting about two months. It should be remarked that not only is the comma bacillus changed by heating so as to apparently lose its poisonousness, while retaining the immunizing properties, but a similar effect seems to be produced by the passage of the electric current.

Vincenzi has made experiments on animals with cultures of the comma bacillus isolated at Massowah. By injecting a minute quantity of such cultures in guinea-pigs, he produced acute subcutaneous edema followed by the characteristic phenomena of cholera intoxication and a fatal termination in less than twenty-four hours. On injecting a few drops of culture into the peritoneal or pleural cavity, death quickly followed. Attempts to produce the infection by introducing the virus into the stomach, were followed by failure. By inoculating pigeons and guinea-pigs with cultures grown in broth and filtered by the method of Kitasato, Vincenzi succeeded in making

them immune, and the protection was very speedily conferred. The serum of immunized animals was found to have the property of being inimical to the cholera germ, and subcutaneous injections of the same, instead of being followed by edematous infiltration accompanied by but few leucocytes, caused edematous inflammation with rapid and effective phagocytosis. Vincenzi also made guinea-pigs insusceptible by inoculating them with a few centimetres of blood drawn from a guinea-pig rendered immune in the way just described, but this protection lasts only a very short time.

Klemperer reports even more astonishing results. This observer has been able, by using intra-peritoneal injections of heated cultures, to rescue animals which had previously received a deadly dose of cholera.

Those of you who have in previous years attended my physiological lectures, remember without doubt, the stress I have laid on the Metchnikoffian attributes of the leucocytes, and while the remarks I am about to make refer to a disease different from the condition we have been studying, still I think they will be of interest in connection with our present subject-matter. In investigating as to the immunity of rabbits vaccinated against the microbe of hog-cholera, Metchnikoff arrived at certain conclusions, among which were: 1st. The bactericidal properties in vaccinated rabbits reside in the phagocytes; 2d. The phagocytes play an important part in the resistance of vaccinated rabbits; 3d. They play an equally important role in the resistance of non-vaccinated

rabbits which have been treated with the preventive serum. It is probable that this liquid exercises, under these conditions, a stimulating effect upon the phagocytes.

Elaborating upon this subject, the Klemperers show the great practical value of laboratory work in connection with the study of the cure and prevention of disease, especially infectious diseases, the experiments upon animals serving to test the value of various modes of inducing immunity.

These observers remark that the value of any system of producing immunity depends first upon the degree of immunity obtained by its use; but when it is also used as a cure, the question of rate of speed of action, has weight. The infection which is to be overcome does not present itself in full vigor at the onset, but gradually culminates, so, the greater the rate of speed at which the inoculation acts, the less serious is the disease which is to be overthrown. For the practical value of this method, it becomes of great importance to know whether it acts specifically—that is, whether the immunity produced by it, has a specific limit. To this we are not yet able to give a positive answer.

Prominent among the great workers in this, as yet, hazy and uncertain field, is M. Haffkine, of the Pasteur Institute, from whose admirable lecture on "Anti-Choleraic Inoculation," delivered at the laboratories of the Royal Colleges, I quote almost verbatim, as follows: The experience acquired in the prevention of hydrophobia by preventive inoculation—the first human disease treated according to the new

method gave observers a perfectly clear plan which they might follow for other human diseases. It was shown that in order to be successful it was necessary to prepare a series of virus, gradually increasing in strength until they reached a fixed degree of virulence greater than that of the ordinary virus, which when used, should permit the organism to become accustomed to a poison more virulent than that which it has to fight against at the moment when infection takes place. The *traitement intensif* of hydrophobia, based upon virus of a maximum strength, has inaugurated the method, and has shown the true role of the virus kept in a fixed state of exaltation by appropriate experiments.

The acquisition of an exalted virus and the establishment of a method suitable to keep it in a fixed state is, then, the starting point and the final aim in the research of a vaccine, for as before stated, it is necessary gradually to accustom the organism under treatment to this fixed virus. It is known that this task may be accomplished by the passing of the infectious organism through a series of animals, and that the microbe would acquire the maximum of its contagious power by cultivating it through a long series of living beings.

Now let us look at this problem as applied to cholera. In the case of this disease the first attempts towards the end in view, were made by trying to infect animals through the digestive canal. In this way the culture of the cholera microbe took place in a medium occupied by a number of foreign microbes, which from the first rendered the means employed

uncertain. The result of the introduction of a microbe into a medium already occupied by other microbes depends upon the nature of the latter, and their presence renders its development sometimes more easy, sometimes, on the contrary, impossible. Besides the purification of the microbe by artificial culture, made with virus transmitted through two animals, is a source of weakness which counterbalances the exaltation.

This explains how Messieurs Pfeiffer and Nocht, in seeking to strengthen the cholera microbe by passing it alternately through animals and cultures, have not been able to obtain a microbe capable of overpowering the natural resistance of birds; and this is the reason why Messieurs Roux and Haffkine, in trying to transfer the intestinal contents from one animal to another, according to the method used by Gamaleia, have seen their series interrupted after the third or fourth transference.

There is no necessity of our going into the discussion of the modes of Gamaleia, of Roux, of Hueppe, or of Pfeiffer, but we will pass at once to the consideration of the Haffkine method, and the experiments of this observer on animals. In the Haffkine researches at the Pasteur Institute, on vaccination against Asiatic cholera, the initial point chosen was the inoculation of the animal into the peritoneal cavity, and starting from this point a method was worked out which permits the culture of the microbe in the animal organism in a state of purity during indefinite generations, the exaltation of it to a determined maximum of strength, and the keeping it at the same

degree of virulence for an unlimited period of time.

This method can be illustrated by three series of experiments, which are:

1st. Giving the first animal a dose larger than the fatal dose, and killing this animal in a sufficiently short space of time to be able to find the more resisting microbes.

2nd. Exposing the exudation taken from the peritoneal cavity, to the air for several hours.

3rd. Then the transferring of this exudation to the next animal, of large or small size, according to the concentration of the exudation.

In the hands of a number of experimenters this method has given the same results and showed a perfect consistency.

The properties of the virus so obtained are as follows: Upon intraperitoneal inoculation it kills guinea-pigs regularly in the space of about eight hours, and the fatal dose for this animal is reduced to about twenty times less than that which it would have been necessary to take, for the microbe with which the start was made. The same inoculation kills rabbits and pigeons with a dose which would have been perfectly harmless at the beginning of the experiments, and kills guinea-pigs by intra-muscular inoculation. The subcutaneous inoculation brings about the formation of a large edema, which tends towards the sequestration of a whole part of the cutaneous tissues, and to the formation of a wide open wound which is cured in from two to three weeks.

The basis of anticholeraic vaccination is founded on the virus obtained in the manner just described.

This virus, when injected under the skin of a healthy animal, gives it after several days, complete immunity from all choleraic contamination, no matter in whatever manner such contamination may arise.

Anticholeraic vaccination of animals in this manner is definitely established, but the operation is not suitable as applied to human beings. The wound following a subcutaneous inoculation is terrible to look at, and in all probability, extremely painful. Besides, although it does not in itself present any danger to the health of the individual, it exposes him to all the complications inseparable from an open wound.

This power of inducing necrosis of the cutaneous tissues may be removed from the exalted vaccine by cultivating it in a temperature of 39° C., and in an atmosphere constantly aerated. Under these conditions the first generations of the cholera microbe would die rapidly, in an interval of two to three days, and therefore care must be taken to sow them again in new media immediately before death, and after a series of generations of this kind a culture is obtained which, if injected under the skin of animals, even in exaggerated doses, only produces a passing edema, and prepares the organism in such a manner that the injection of exalted virus, the definitive vaccine, only produces a local reaction of slightest description.

The method of vaccination thus worked out comprises then two vaccines—a mild vaccine, obtained by weakening the fixed virus; and a strengthened

vaccine, which is presented by the virus itself. It is easy to understand why to obtain the weakened vaccine we do not use an ordinary virus, but a virus the nature of which has been previously fixed in the laboratory. It is because the virus such as is found in the natural state, especially when it has a saprophytic phase of development, presents such pathogenic differences that there is no certainty in its application. Respecting this, you may recall to mind the attempt made in 1885 by Dr. Ferrán, of Barcelona, who, with the object of preserving the population of the Peninsula from cholera, made injections in his patients of the ordinary virus taken from dead bodies and cultivated in his laboratory. The statistics of the results obtained by this means showed such uncertainty that no one dared to recommend this operation to his country in spite of the very many trials made in Spain.

The possibility of treating the animal organism by vaccines of an absolutely fixed nature, prepared by means of special operations, constitutes, on the other hand, the basis of the Pasteurian method, and here lies the whole secret and the sole guarantee of the success of its application.

The method of anticholeraic vaccination worked out by experiments on guinea-pigs, was tried upon rabbits and pigeons before it was applied to men. These animals were chosen in order to have subjects very differently organized, and in order to be able to generalize the conclusions, and to be able to extend them to the human organism.

The results obtained on all these animals being ab-

solutely the same, it was decided to apply the operation to man.

The method has been tried at Paris, at Cherbourg, and at Moscow, on about fifty persons of both sexes, between the ages of nineteen and sixty-eight, of French, Swiss, Russian, English and American nationality.

In every instance the method has shown itself absolutely harmless to health, and the symptoms that it evokes are, a rise in temperature, a local sensitiveness at the place of inoculation, and the formation of a transitory edema at the same place. The first sensations are felt about two or three hours after inoculation; fever and general indisposition disappear after twenty-four to thirty-six hours; the sensitiveness and edema last, gradually dying away in from three to four days. The symptoms following the second inoculation are generally rather more marked but of shorter duration. The whole recalls the sensation of a bad cold lasting about one or two days. The microbes introduced under the skin do not propagate, but after a short time they die and disappear. It is the substances which they contain, and which are set free when they die, that act upon the animal organism and confer immunity upon it. It is found that the same result can be obtained if the microbes be killed before inoculation, and if their dead bodies only be injected. Thus vaccines have been prepared and preserved in weak solutions of carbolic acid. In this the microbes die at the end of several hours, and the vaccine so prepared has been found still efficacious six months after its preparation.

Haffkine is not able to speak as to the length of the period that immunity lasts, and sufficient time really has hardly elapsed to answer this question intelligently. This much can be said, and that is, the inoculations upon man added to the hundreds of experiments that have been made upon animals, testify to the perfect harmlessness of these operations, and Haffkine states positively, there is no difficulty in proving their efficacy by experiment, no matter on what species of animal.*

The test question that faces us for reply now is: Does the protection that we have seen given to the lower animals, become applicable to human beings? This fact as yet has not been positively demonstrated, and more observation is required before we can speak definitely. In the first place, are we doing right in reasoning that because a given method produces certain results in guinea-pigs and rabbits, that it will induce the same effects in man? Is not this argument a very weak one? On the other hand is it possible that a process that renders so many of the

*Under date of May 3rd, 1893, M. Haffkine reports from Agra that up to that time 836 persons had been vaccinated against cholera, and from this number, the most important groups are represented by 51 children, from the age of 6 years from St. Peter's College, which was done with the Archbishop's permission; 230 men of the transport lines of Agra, and 120 men from the police force. At the same time preparations have been made for the vaccination of soldiers, permission having been granted by the commander-in-chief from Simla. At Aligarh 55 persons had been vaccinated. While these groups are of interest in studying the value of the method, the number is yet too small, and it must also be taken into consideration that in the district in which M. Haffkine has been working, the cholera mortality is not very large. Larger groups must be operated on, and the lower provinces at the mouth of the Ganges, where cholera thrives plentifully, must be invaded. M. Haffkine states that so far his vaccinations have been performed without the occurrence of any inconvenience or accident.

lower animals resistant to the cholera poison, would have no such power in man, an animal high in the scale? It is very, very dangerous to reason by analogy. Just because in one family of animals a certain series of tubes being found normally straight, does not indicate that in another species of animals the finding of the corresponding tubules in a convoluted condition would be pathological. Haffkine has demonstrated however that his virus does confer topical immunity upon human beings. For instance, if an individual be inoculated in subcutaneous tissue with active choleraic germs, there results an edematous tumefaction and injection which remains for several days, and which leaves behind a hard nodular mass. No such condition or reaction takes place in persons who have received the protective inoculation.

The field is so far a comparatively unexplored one; there is much room therein for future work. Peradventure there is some one here listening to me at this very time who will solve the many problems that now seem so difficult; some one here with us to-day who will perhaps in the near future, lift another one of the many veils that are hanging between us and the glories of truth and knowledge and light.

And now, I must needs come to a close, for my task is finished. Here ends my course. And if I had no more than this to say, I would say it with something like pleasure, and you, as well as myself, would be glad that at length a resting time and breathing-space had come. But it is with deep regret that I am

forced to announce that this is not only the last lecture of this course, but also the last lecture on any subject that I shall ever probably deliver in this college.

No one is more fully aware, than myself, of the imperfections of these lectures. I have had no official connection with the Chair of Practice of Medicine but have delivered these lectures to you on account of a personal request from the distinguished gentleman and learned physician who is its honored incumbent; and this in addition to the regular work belonging to my own chair. And I confess to you, that I began my course with a certain amount of trepidation, on account of being brought into direct comparison with so eminent a teacher as Professor Quine. Reluctantly leaving the work that for the past two years, I have done in this branch, it is a source of the most profound gratification to me, that my relations with yourselves have always been pleasant: from you I have never received any but the kindest greeting, and the most courteous and respectful attention, and for this I thank you most sincerely. And now, in almost a few short hours you will go forth from the halls of your *Alma Mater*, to put into practice, what you have been taught concerning **medicine and surgery**.

From other members of this Faculty, more capable of giving it than myself, you will receive advice that will be of value to you. But you will permit me to say that in commencing your career you will do well to bear this admonition in mind: Be pure, be honest, be conscientious, be studious and be brave. Be

not afraid of doing that which your conscience tells you is right, because it may not be popular. Be patient, and lay in a good supply of what is called "grit." Believe me, he who strikes the iron long enough and hard enough, will be sure ultimately to make it hot; and the faculty of stick-to-it-iveness in the long run, will more than compensate for perhaps a lack of genius, or a deficiency as to brilliancy of intellect. It has been said that many a noble idea is clothed in humble language, and this I thought a few days ago on reading an unpretentious verse, which I will here repeat:

I observed a locomotive in a railroad yard one day,
It was waiting in the round-house, where the locomotives stay:
It was panting for the journey, it was coaled and fully manned.
And it had a box the fireman was filling full of sand.

It appears that locomotives can not always get a grip
On their slender iron pavement, 'cause the wheels are apt to slip;
And when they reach a slippery spot, their tactics they command,
And to get a grip upon the rail, they sprinkle it with sand.

It's about this way with travel along life's slippery track,
If your load is rather heavy and you're always sliding back;
So, if a common locomotive you completely understand,
You'll provide yourself on starting, with a good supply of sand.

If your track is steep and hilly and you have a heavy grade,
And if those who've gone before you, have the rails quite slippery
made,"

If you ever reach the summit of the upper table land,
You'll find you'll have to do it with a liberal use of sand.

If you strike some frigid weather and discover to your cost
That you're liable to slip on a heavy coat of frost,
Then some prompt, decided action will be called into demand,
And you'll slip 'way to the bottom if you havn't any sand.

You can get to any station that is on life's schedule seen
If there's fire beneath the boiler of ambition's strong machine,
And you'll reach a place called Flushtown at a rate of speed that's
 grand,
If for all the slippery places you've a good supply of sand.

PREScriptions THAT HAVE BEEN RECOMMENDED
IN CHOLERA.

Inosemzeff's Anti-Cholera Mixture.

- ℞ Tinct. rhei compositæ, m. v
Tinct. rhei spirituosæ, m. ij
Tinct. opii,
Tinct. valerian. ætherosi,
Tinct. menthæ piper.,
Spts. ætheris comp., aa ʒij
Olei menth. piper., m. xxvj
Extract. nucis vomicæ, gr. jvss
M. sig.—Fifteen to twenty drops at a dose.

Hamlin's Cholera Mixture.

No. 1.

- ℞ Tinct. opii,
Tinct. camph, aa 1 part
Tinct. rhei, 2 parts

Misce.—

No. 2.

- ℞ Tinct. opii,
Tinct. capsici,
Tinct. cardam. co.
Ginger, aa equal parts

Misce.—

Ruschenberger's Cholera Mixture.

- ℞ Tinct. zingiberis,
Tinct. capsici,
Tinct. piperitæ,
Tinct. opii, aa equal parts

Misce.—

Chlorodyne.

- ℞ Choloroform, ʒ ss
Spts. ætheris sulph., ʒ iss
Ol. menth. pip., gtt. viij
Olei-resin. capsici, gtt. ij
Ext. cannabis ind., gr. vj
Morphiæ muriatis, gr. xvj
Acid. hydrocyanic. dil. m. lxv
Acid. hydrochloric, dil., ʒ j
Glycerine. et mellis. q. s., ad ʒ jv

M. sig.—Dose, fifteen to twenty drops.

Bengal Cholera Pill.

℞ Pulveris piper, niger.,
 Assafoetidæ aa gr. j
 Camphoræ, gr. ij
 M.—et ft. pil. No. 1.

Macnamara's Pill.

℞ Pulv. opii, gr. j
 Plumbi acet. gr. ij
 M.—et ft. Pil. No. 1.
 Sig.—One pill pro re nata.

Hope's Mixture.

℞ Tinct. opii,
 Acid. nitrici dil., aa $\frac{7}{8}$ ss
 Aquæ camph., $\frac{5}{8}$ jv
 M. sig.—Teaspoonful as occasion requires.

For Vomiting.

℞ Cocaini hydrochlor., gr. iij
 Tinct. menth., $\frac{3}{4}$ ij
 M. sig.—Ten drops every half hour until vomiting
 is arrested.—LAZARAFF-PRZEDBORSKI.

Camphor Wine.

℞ Finely powdered camphor, gr. lxxv
 Gum arabic, q. s.,
 Alcohol, q. s.,
 Strong red wine, 1 bottle
 Use enough of alcohol to dissolve the camphor,
 then add to the wine.

Sig.—Teaspoonful in peppermint tea every hour to a
 child of six years; for an older child a dessertspoonful; and for
 an adult a wineglassful.—HARE.

℞ Acid. lactic, $\frac{3}{4}$ iij
 Syrupi simpl., $\frac{3}{4}$ vj
 Tinct. limonis gtt. xxx

M. sig.—Place in a quart of water, and give from one to
 three dessertspoonsful every quarter of an hour. BUCQUOY.

℞	Ethereal tinct., of valerian,	m. lxxv
	Sydenham's laudanum,	m. xv
	Essence of peppermint,	m. v
	Hoffman's anodyne,	m. lxxv

M. sig.—Twenty-five drops every few minutes until tendency to vomit is relieved.—LAUSSE DAT.

℞	Tinct. cinnamon,	℥ ij
	Bismuth. subnitr.,	℥ j
	Sydenham's laudanum,	m. xij
	Syrup. acaciæ,	℥ ijss

M. sig.—Teaspoonful every two hours.—BUCQUON.

℞	Acid. sulph. aromat,	℥ ss
	Ol. cajuputi,	gtt. xv
	Ext. hæmatoxyli fld,	℥ ij
	Spts. chloroform.,	℥ j
	Syr. zingiber.,	℥ ij

M. sig.—Teaspoonful in water every two hours.—HARE.

Disinfecting Washes.

℞	Hydrarg. chlorid, corrosiv.,	gr. xv
	Acid. hydrochlorici,	℥ ijss
	Aquæ destil.,	℥ xx

M. sig.—*Poison*, use as a wash.—G. DAREMBERG.

℞	Acid. phenic.,	℥ ij
	Acid. salicyl.,	gr. xv
	Acid. lactic,	gr. xxx
	Aquæ destil.,	℥ xx

M. sig.—*Poison*, use as a wash.—G. DAREMBERG.

Sun Cholera Mixture.

℞	Tinct. rhei,	
	Tinct. opii,	
	Tinct. capsici,	
	Spts. camph.,	
	Spts. menth. pip.,	aa ℥ j

Misce.—

Thielmann's Mixture.

℞	Vini opii,	℥ j
	Tinct. valerian,	℥ ij
	Æther,	℥ jv
	Ol. menth. pip,	℥ j
	Ext. ipecac. fld.	m. xv
	Alcohol. q. s., ad.	℥ jv

Misce.—

Loomis' Mixture.

R	Tinct. opii,	℥ jv
	Tinct. rhei,	℥ jv
	Tinct. catechu, co.,	℥ j
	Ol. sassafras,	m. xx
	Tinct. lavend. co., q. s., ad,	℥ jv

Misce.—

Velpeau's Mixture.

R	Tinct. opii,	
	Tinct. catechu. co,	
	Spts. camph,	aa ʒ j

Misce.—

Diarrhea Powder.

R	Bismuth. subnitr.,	gr. xv
	Benzo-naphthol,	gr. x

M.—et ft. chart. No. 1.

Sig.—Give a powder as above, three times a day.—

G. DAREMBERG.

Solution for Hypodermoklysis or Intravenous Transfusion.

R	Aquæ destil.,	O ij
	Sod. chlorid.,	gr. lxxv to c
	Sod. sulphat.,	ʒ ijss

M.—et ft. solut.—HAYEM CANTANI.

Cantani's Enteroklysis Solution.

R	Acid. tannic,	ʒj to iij
	Aquæ destil.,	O jv
	Gum. acaciæ	ʒ xjv
	Tinct. opii,	gtt. xxx to l

M.—et ft. enema.

Sig — Inject the above quantity as high up in the bowels as possible. Do this four or five times a day.

R	Strychninæ sulph.,	gr. 1-16
	Morph. sulph.,	gr. ⅓
	Ergotine—Yvon-sick.,	gr. v
	Aquæ destil.,	ʒ j

M.—et ft. solut.

Sig.—Inject hypodermically in abdominal wall. Repeat in an hour, in succeeding injections the strychnine may be omitted, and if narcotism be shown, omit the morphine.—P. R. BROWN.

℞ Argenti nitras., gr. ss
Confectio. rosæ, q. s

M.—et sec. art, ft. pil. No. xv.

Sig.—From one to three pills in water, several times a day. Begin with a large dose, which is to be lessened as patient improves.—ODARTCHENKO

℞ Sulphuris præcipitati.
Sodii. bicararbonas, aa jv
Spts. lavendulæ comp, ℥ xxjv
Aquæ, ℥ lxxij

M.—Triturate the soda and sulphur together in a mortar, then add gradually the spirit of lavender, till the whole is well mixed, when the water is poured in.

Sig.—Dose, two teaspoonsful in a little water, every two, three, or four hours, in simple choleraic diarrhea; but when urgent, every ten or fifteen minutes.—J. GROVE.

℞ Plumbi acetatis, gr. xxx
Acidi acetici, m. x
Aquæ destillatæ, ℥ vj

M.—Sig.—Two to three tablespoonsful every half-hour or hour.—FLEMING.

Liniment.

℞ Tinct. opii, ℥ ij
Lin. saponis, ℥ j
Aq cologniensis, ℥ ij
M.—et ft. liniment.

Sig.—For external use only. Rub extremities gently with some of the liniment poured into palm of hand ---WENDT.

℞ Chloroform, ℥ i-ij
Syr. quiniæ, ℥ ss
Aquæ destil, ℥ iij

M. sig.—Give a tablespoonful every half hour in tea. —PARROT.

℞ Chloroform m. xv
Alcohol, ℥ ij
Ammon. acetat, ℥ ijss
Syr. morpn. hydrochlor, ℥ j¼
Aquæ destil., ℥ ijss

M. sig.—Tablespoonful every half-hour.—M. DESPREZ.

℞ Acid. sulph. aromat,	℥ jv
Magnes. sulph.,	℥ jv
Tinct. opii,	℥ jv
Elixir, Simpl.,	℥ j
Aquæ,	℥ ij

M. sig.—Teaspoonful in a little water every three, four or six hours according to the frequency of the stools—

N. S. DAVIS.

℞ Quiniæ sulphat.,	℥ j
Acid. sulph. aromat,	q. s., ad solv.
Aquæ destil ,	℥ iiij

M. sig.—Give one tablespoonful, repeat at once should vomiting occur, and afterwards at intervals of an hour and a half, until thirty grains have been given, and thereafter *pro re nata*.—FULLERTON.

℞ Acid. lactic,	℥ ij
Syr. limonis,	℥ jv
Aquæ destil.,	℥ xxxij

M. sig.—To be taken through the day.—MEDICAL NEWS.

℞ Chloroform,	℥ ij
Spts. camphor,	
Tinct. opii,	aa ℥ jss
Ol. cinnamon,	gtt. viij
Alcohol,	℥ iiij

M.—Et ft. tinctura.

Sig.—Dose, from five to thirty minims, or more as required.—WENDT.

Voronej's Anti-Cholera Elixir.

℞ Ammon. Muriat,	℥ x
Olei naphthæ,	℥ vj
Olei caryophilli,	℥ x
Acid nitrici,	℥ vj
Potass. nitrat.,	
Turkey pepper,	aa ℥ jss
Menth. virid.,	℥ viij
Aceti,	℥ j
Sprts. vini gallici	℥ jv

Misce.—

R	Acid sulphurici,	℥ ss
	Morphiæ sulph.,	gr. ⅓.
	Spts. vini gallici,	℥ iss
	Aquæ destil.,	℥ iiij

M. sig.—Inject under skin of arms, legs, and over stomach every hour, until symptoms are relieved.—R. W. MITCHELL.

R	Ext. cannabis ind.,	gr. xvj
	Camphoræ,	℥ ss
	Chloroformi,	℥ ss
	Olei terebinth,	℥ ij
	Mucil. acaciæ,	
	Syr. simplicis,	aa ℥ ss
	Aq. cinnamon,	℥ j

M. sig.—Tablespoonful every one or two hours.—G. B. THURSTON.

R	Creasoti,	gt. j
	Aq. camphor,	
	Infus. gent. co.,	aa ℥ vj

M. sig.—At a dose, and repeat every two hours.—J. T. JONES.

R	Sodii chloridi,	℥ ij
	Sodii carbonatis,	℥ ij
	Potassii chloratis,	℥ ij
	Aquæ destil.,	℥ vj

M. sig.—Two tablepoonsful in water every half-hour.—WM. STEVENS.

Murray's Cholera Pill.

R	Pulveris opii,	gr. j
	Piperis,	gr. ij
	Assafœtidæ,	gr. iiij

M.—et ft. pil. No I.—JOHN MURRAY.

Edward R. Squibb's Mixture.

R	Tinct. opii. depurat.,	
	Spts. camphoræ,	
	Tinct. capsici,	aa ℥ j
	Chloroformi purif.,	℥ iiij
	Alcohol—95 per cent. q. s., ad,	℥ v

M.—Each fld. drachm or teaspoonful contains about 100 drops, and consists of twelve minims of each of the first

three ingredients, and four and a half minims or eighteen drops of the chloroform.—Dose, is one teaspoonful for persons over 18 years of age; a small teaspoonful for persons 14 to 18 years; for those 10 to 14 years, a half teaspoonful; for those 6 to 10 years, thirty drops; for those 2 to 6 years, ten to thirty drops; for infants, one to ten drops. To be taken in water.

℞ Chloroform, m. xv-xx
Tinct. opii, m. x-xv
Spts. vini, ʒ i
Aquæ destil., ʒ j

Misce.—T. M. LOWNDES.

℞ Acid. sulphuric. aromat, ʒ j
Tinct. opii deodorat, ʒ ss

M. sig. Ten to twenty drops every half hour or longer as required, in some cold water.—ROBERTS BARTHOLOW.

℞ Acid. hydrochloric, ʒ ss
Cocaine hydrochlorat, gr. ij
Tinct. opii, ʒ ss
Aq. dest., v
Syr. simpl., ʒ vjss

M. sig.—Teaspoonful every two hours.—MENDEL and SIMON.

℞ Acid. tannici,
Plumbi acetat., aa gr. xij
Opii, gr. ij
Oleoresinæ capsici, gr. ij

M.—Ft. pilul. No. xij

Sig.—One pill every one, two, three, or four hours.—

ROBERTS BARTHOLOW.

℞ Acid. tannic, ʒ j
Camphoræ, gr. x
Opii, gr. ij

M.—Ft. pil. No. xx

Sig.—One pill every hour or two.—ROBERTS BARTHOLOW.

℞ Bismuth subnitrat, ʒ ij
Plumbi acetat. gr. xij
Camphoræ gr. vj
Oleoresinæ capsici gr. ij

M.—Ft. chart. No. xij

Sig. —One powder every hour or two.—From BARTHOLOW's "Cholera."

R Iodoformi ℥ j
 Naphthalin ℥ ij
 Bismuth. salicylat. ℥ ij

M.—et ft. chart. No. xx.

Sig. One every hour or two in milk.—BUJWID.

R Sod. phosph. (cryst.) 5 parts
 Sod. sulph. 10 "
 Aq. destil. 100 "

M.—Boil and filter.

Sig.—For subcutaneous injection.—LUTON, (of Rheims.)

R Acid boric (seu Lactic) ℥j ℥ij
 Aq. ferventis O ij

M. s.—For stomach lavage.—HAYEM-LESAGE-DELPECH.

R Hydrarg. chlor. cor. gr. j
 Aq. dest. ℥ j

M. sig.—For hypodermatic use—m xx for initial dose, and m. x every half hour or hour.—ROBERTS BARTHOLOW.

R Caffein ℥ ss
 Sod. Benzoat. gr. xl to l
 Aq. dest. ℥ ijss

M. S.—m. xx (a hypodermic syringe-ful) equal nearly gr. v of caffein. This can be repeated every 2, 3 or 4 hours.—Paris Formula from BARTHOLOW's "Cholera."

In Threatened Collapse.

R Strychnine sulphatis, gr. ¼
 Acidi sulphurici diluti, ℥ ss
 Morphinæ sulphatis, gr. ij
 Aquæ camphoræ, ℥ ijss

M. sig.—A teaspoonful well diluted, every hour or two.—ROBERTS BARTHOLOW.

Cantani's Solution for Hypodermoklysis.

R Water, sterilized O ij
 Salt ℥ ijss
 Carbonate of sodium grs. lxxvij

M.—et ft. solut.

Samuel's Solution for Hypodermoklysis.

R. Water, sterilized O ij
 Sodium chloride 3 j

M.—et. ft. solut. To be used at 104° F. To this solution *Rumpf* adds hydrogen dioxide, *Herse*, alcohol, and other authorities add, thymol, or boric acid, etc.

Nothnagel's Solution for Hypodermoklysis.

R. Water, sterilized O ij
 Sodium chloride 3 ij
 Sodium carbonate gr. xcijj

M.—et ft. solut.

In Algid Stage.

R. Quiniae hydrochlorat, ʒ j
 Aq. dest., ʒ iiij
 Sod. chlorid, gr. x

M. sig.—Inject two syringesful, carrying about gr. xvijj of the quinine.—NEDZWEDZKI.

R. Chloroform,
 Spts ætheris comp.,
 Spts. camphoræ, aa equal parts

M. sig.—Teaspoonful now and then in water, as occasion may require.—CHAUNCEY F. CHAPMAN.

New York Quarantine Plan of Treatment.

Patients and suspects are required to drink freely of hydrochloric acid lemonade, 1 to 1000, and stomach lavage is practised every two hours with tannin solution or solution of hydrochloric acid, 1 to 1000. Cantani's enteroklysis is performed every two hours, with a 2 per cent. aqueous solution of tannic acid, half a gallon being used at a time at a temperature of 108.9° F. A rectal tube, two feet long, is introduced as far as possible, and passage through the colic valve is aided by external manipulation, massage. At the outset gr. x of calomel are exhibited, and repeated every hour until three doses have been given or until free purgation has been induced. Then gr. ss is exhibited every two hours. Stimulants are used pro re nata, preferably brandy, and usually hypodermatically. As soon as cholera asphyxia appears hypodermoclysis is resorted to, the solution used being 3 parts of sodium chloride, 10 parts of brandy to 1000 parts of sterilized water at a temperature of 104° F. One quart is the amount used for an adult, and it is injected into the flanks at about the level of the eighth rib, and repeated every second to fifth hour, according to urgency of the case. The largest amount reported used in any one case, is eleven quarts.



Bronze Medal cast by the City of Paris to commemorate the invasion of that city by cholera in 1832. The original, of which the above is an exact reproduction, is in the possession of Dr. Joseph H. Hunt, of Brooklyn, N. Y.

APPENDICES.

APPENDIX A.

Too much attention can hardly be paid to the Bacteriological Subdivision of our subject-matter. Before Koch's discovery of the specific, exciting etiological factor of the disease, there were no means whereby a local epidemic of true cholera could be recognized with certainty in the early stage, or of ascertaining whether the disease had left a given locality or not. As a result, the requisite sanitary precautions were either adopted too late or abandoned too soon. Now, however, we are acquainted with almost every detail of the development and progress of the disease.

In certain cases of true cholera the clinical picture does not permit the physician to make a diagnosis on account of the resemblance of the symptoms to those of cholera nostras, cholera infantum, certain forms of peritonitis, poisoning with arsenic and various organic substances. The only distinguishing feature between true cholera and the affections above mentioned, may be the highly infectious and fatal character of the malady. During an epidemic when perhaps proper bacteriological examinations can not be had, all such cases should be in every way treated on the basis of true cholera. In both hospital and private practice though, bacteriological examination should be resorted to as a routine measure. Such examinations should be made of the stools of individuals recovering from cholera, as the bacilli in a most virulent form, are apt to persist in the motions long after the choleraic symptoms have subsided.

Accurate and rapid diagnosis, and the adoption of prophylactic measures are always questions of paramount importance, but become especially so at the beginning and toward the end of an epidemic.

Bacteriological diagnosis must be prompt, and of unsuspected accuracy to be of real service, as so rapid is the spread of the disease that the delay of a single day may lead to disaster. For this

reason those making the examinations must be of undoubted skill, as the interests involved are too great to be imperilled by amateurs or careless operators.

APPENDIX B.

Prof. Koch's Instructions for Bacteriological Examinations.

1. *Microscopical*.—This consists in the examination of cover-glass preparations obtained from fecal material and alvine discharges. The mucoid concretions found in the stools, or after death, in the intestines, should be selected. Ziehl's dilute fuchsin solution is the best staining reagent.

These slides vary in appearance according to the severity of the case and the stage of the attack. They may either show pure—or nearly so—cultures of cholera spirilla, or mixed cultures in which the spirillum is found associated in variable proportions with the micro-organisms found in the intestine, especially the bacterium coli commune. Sometimes the slide will not reveal the presence of any comma-shaped organisms. (At Massaouah the bacillus is met with in the form of straight rods.—*Liebreich*.)

In a preparation showing a pure culture, or in one in which the bacterium coli commune is the only other organism present, the cholera bacilli appear in clusters, which are especially characteristic where the mucus has been drawn out in filaments. This arrangement is peculiar, inasmuch as the bacilli all point in the same direction and resemble a file of fishes swimming one behind the other, in a slowly flowing stream of water. (Koch looks upon this as being specific, characteristic and indicative of Asiatic cholera.) This feature may be absent, and in spite of its absence, the diagnosis is just as certain when the only organism found in the preparation is the bacterium coli commune mixed with a large number of bacilli presenting the physical characteristics of cholera organisms. The existence of other bacteria introduces an element of doubt as to diagnosis. The value of microscopical examinations is in direct ratio to the skill of the operator. With one trained and able to recognize cholera bacilli at a glance, by thorough acquaintance with the morphological appearances of the organisms, the method is a great aid to rapid diagnosis, and the advantages of a rapid diagnosis from a prophylactic point of view, are obvious to those who know that

precautionary measures against cholera can never be adopted too soon. (In a case in which culture experiments had been unsuccessfully performed for four days, Koch discovered that the very first microscopic preparation might have enabled the physician to form a correct diagnosis.)

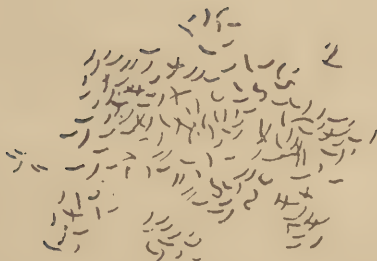
2. *Cultures on Peptone Solutions*.—Dunham observed that the bacilli of cholera grow and increase with great rapidity in a sterilized one per cent. peptone solution, to which five-tenths per cent. of chloride of sodium has been added, and kept at the temperature of the blood. The fluid shows turbidity six hours after inoculation, and on the addition of sulphuric acid a red color is produced. The reaction is more delicate and the red color more intense under these circumstances than when the bacilli are grown in broth with, or without the addition of peptone. Dunbar at the Public Health Institute, in Hamburg in the last epidemic, used this test with success. The technique is as follows:

To a test tube containing a sterilized one per cent. solution of peptone, a few drops of choleraic dejections, or a small quantity of mucus from the stools, are added by means of a looped platinum wire. The tube is then kept at a temperature of 57° C. Hesse shows that cholera bacilli are essentially aerobic. They have a tendency to rise to the surface of the solution where they are able to multiply, away from the disturbing influence of the other organisms normally present in the feces. At any rate, during the early stages of the process, the latter remain in the deeper parts of the fluid. If a few drops of the peptone solution are taken from the surface with the platinum loop and examined under the microscope, as soon as some turbidity appears, the fluid is found to contain a pure culture of cholera bacilli, provided these organisms were present in sufficiently large numbers in the dejections or mucus originally employed. In cases in which the latter contain but few bacilli these take a longer time to rise to the surface, and they are then usually mixed in variable proportions with the ordinary intestinal micro-organisms, especially with the bacterium coli-commune. Under these circumstances the element of doubt exists as to the real nature of the curved bacilli that are present.

Positive results may be obtained by means of peptone cultures, where plate cultures entirely fail. In all probability this is owing to the fact that on gelatine plates the cholera spirilla are overcome

by the saprophytic bacteria present from which they cannot escape as in peptone solution, and their development is interfered with and their presence obscured. Valuable as the peptone cultures are, they only afford positive evidence in cases in which the surface of the fluid yields a pure culture of the organism under consideration. The culture should be examined between six and twelve hours after inoculation. Sometimes, however, a longer period must be allowed to elapse. Now and then a few drops must be examined so as to determine the exact time when the culture reaches its maximum development. Care must be exercised as to the grade of peptone employed. At the Berlin Institute for the Study of Infectious Diseases, that prepared by Witte (Rostock) is used in preference to all others. The peptone should contain twenty-five milligrammes of carbonate of soda to each cubic centimetre, the amount being determined by volumetric analysis, with litmus paper as an indicator. (Peptone is a substance of very unstable composition, in spite of the most careful preparation, and the peptones of commerce are not all suitable for purposes of experiment.)

3. *Cultures on Gelatine Plates.*—Although less delicate than peptone cultures, the plate cultures confirm and complete the latter. In the course of a few hours in using a peptone culture, bacilli are present in sufficient numbers to permit of successful inoculation on gelatine plates. Three solutions of gelatine are prepared in the ordinary way, and poured into covered glass dishes. The higher the temperature, the more rapid is the development of the colonies on the plates. The best temperature is about 22° C. for a properly prepared ten per cent. solution of gelatine. At the end of from fifteen to twenty hours, under these conditions, the plates will show characteristic colonies. When the temperature rises above 22° C. the gelatine liquefies and the colonies break up. It is therefore necessary to use an auto-regulating incubator, which will maintain the temperature standard, variations never to exceed half a degree above or below 22° C. When the cultures are exposed to a higher temperature or when an inferior gelatine solution fusing at 22° is used, the cholera colonies rapidly liquefy the medium of culture and they then closely resemble the spirillum of Finkler, for which, indeed, they may be mistaken by inexperienced investigators. Under ordinary conditions, cholera colonies obtained from freshly isolated organisms, on properly prepared gelatine kept at a moderately high

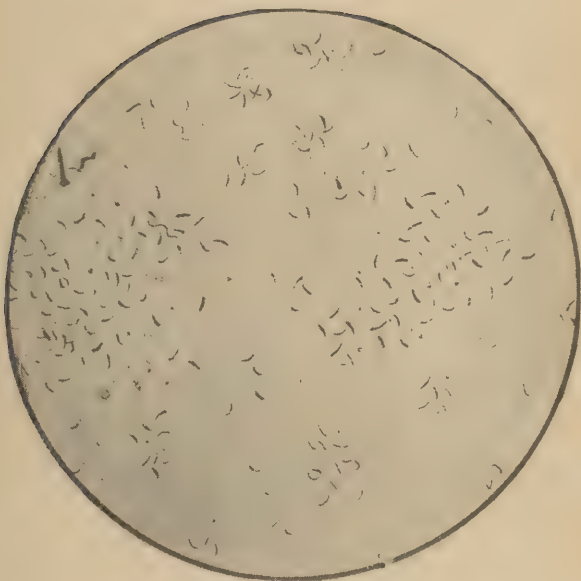


Spirilla Cholerae Asiatica, pure culture (prepared by Franklyn J. Tower).
Leitz Oil Immersion Lens 1-12th, ocular No. 5,
magnified 1200 times.

temperature, present characteristic and easily recognizable appearances; but it must be borne in mind that such appearances may be modified to a greater or lesser degree, as for instance by the fact that the bacilli had been isolated a long time before inoculation, by changes in the composition of the gelatine, a low temperature, etc.; these cases are, however, exceptional. When they occur, other methods of investigation will always permit accurate diagnosis.

4. *Cultures on Agar Plates.*—While these may be looked upon as being simply a modification of the method of cultivation on gelatine plates, they differ in several important particulars. The agar colonies are not so characteristic in appearance as those on gelatine. They form medium sized transparent aggregations of a peculiar brownish-gray color. An advantage possessed by the agar cultures is that they can be exposed safely to a high temperature (37° C.) with the result that in from eight to ten hours the plate shows a sufficient number of colonies to permit of further study. In using agar the colonies must develop on the surface, for they grow but slowly in the depth of the nutrient medium, where they never reach any considerable size. For this reason the agar must first be allowed to solidify and it is then to be inoculated on the surface with the help of a platinum loop. In order to prevent the surface of the agar during the process of setting from becoming covered with a film of water, it should be kept for a few days in the incubator until the fluid has entirely evaporated. After inoculation the plates are to be kept in the incubator at a constant temperature of from 37° to 38° C. Agar cultures are not well adapted for purposes of experiment, when the fluid to be experimented with contains but few cholera organisms. When the bacilli have multiplied for from six to ten hours in peptone solution and are then transplanted to agar plates, after another period of from six to ten hours, a comparatively large number of pure colonies are produced. After microscopical examination these agar cultures are valuable for use in inoculating fresh peptone tubes which very soon will exhibit the red cholera reaction, or for experiments on the lower animals.

5. *Red Cholera Reaction.*—Discovered almost simultaneously by Bujwid and Dunham, consists of the appearance of a red color on the addition of sulphuric acid to cholera cultures, which always contain a certain quantity of indol and nitrous acid. Indol is likewise produced by other bacteria, and a third group of organisms is



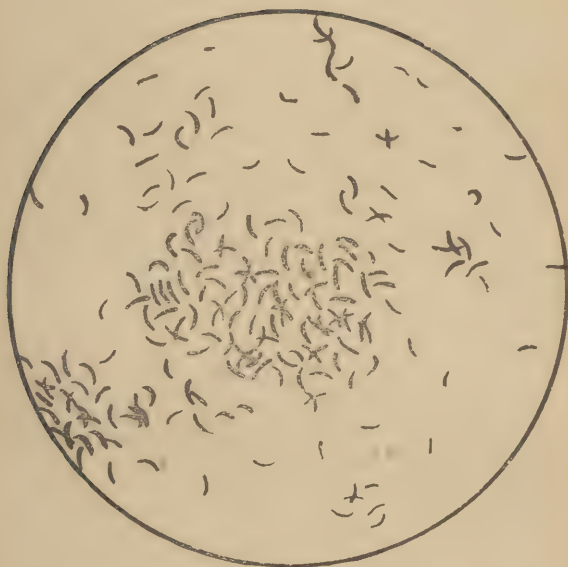
Spirilla Cholerae Asiatica, sediment of bouillon culture, (Franklyn J. Tower). Leitz 1-8th, ocular No. 5, magnified about 600 times.

capable of reducing nitric to nitrous acid. Moreover it is possible that there are other micro-organisms, which like the cholera spirilla can produce both indol and nitrous acid, but this power is not possessed by any of the known species of comma-shaped organisms capable morphologically of being confounded with cholera bacilli. For success in performing this test the following conditions must be attended to:

1st. Care must be exercised to select a good preparation of peptone, and the delicacy of the reaction can be increased by raising or lowering the proportion of nitrates present in the peptone solution. 2nd. The sulphuric acid used should be absolutely free from all trace of nitric acid. 3rd. The cultures of cholera bacilli should be perfectly pure, so as to remove all elements of doubt as to what organism has produced the reaction, a doubt which might easily exist should a mixed culture be employed. 4th. The test should only be employed with pure culture of bacilli in sterilized peptone solution.

6. *Experiments on Animals.*— It has been for some time known that cultures of cholera bacilli injected into the peritoneal cavity of guinea pigs produce a toxic effect on these animals. Constant and definite results can only be obtained with cultures of cholera organisms on agar. R. Pfeiffer takes with a looped wire about fifteen decimilligrammes (as much as the loop can hold) of cholera culture from the surface of the agar. This is diluted in about one cubic centimetre of broth and injected into the peritoneal cavity. Care must be exercised that the fluid be not injected into the intestine by pushing the needle through the intestinal wall. To cause effect the amount of the culture injected must bear a certain relation to the size of the animal. For a guinea pig weighing from three hundred to three hundred and fifty grams, the quantity of cholera culture, which can be held in the loop of a platinum wire, is usually a fatal dose. Soon after injection the phenomena of intoxication appear, prominent among these being a fall of the temperature, culminating rapidly in death. A few agar colonies are sufficient for this experiment.

By means of the various methods of investigation above described, we are enabled in every case rapidly to form an accurate opinion of the exact nature of the disease. The secret of success lies in their rational application, that is to say, in combining them



Spirilla Cholerae Asiaticæ, pure culture, (prepared by Franklyn J. Tower). Leitz Oil Immersion Lens 1-12th, ocular No. 5, magnified about 1200 times.

so as to obtain the maximum amount of information therefrom. They may with advantage be substituted for the older methods of cultivation on potatoes, in gelatine tubes, etc., which may now be dispensed with.

APPENDIX C.

Prof. R. Koch's Rules for the Examination of Water.

To a large quantity (100 c.c.) of the water to be examined, add one per cent. of peptone and one per cent. of sodium chloride, and keep the mixture at a temperature of 37° C. At the end of ten, fifteen or twenty hours, a number of peptone tubes and agar plates are inoculated with this culture. Under these circumstances the microscopic examination of the peptone cultures is of but secondary importance, seeing that comma-shaped bacilli resembling cholera spirilla are almost always to be found in water from whatever source. On the other hand, all suspicious colonies on the agar plate must be carefully examined under the microscope; should they be found to consist of comma organisms, the latter should be transferred to fresh culture media for the red cholera test and experiments on animals. No examination of water is complete which is not confirmed by experiments on animals.

APPENDIX D.

At the Moabit Hospital in Berlin, the authorities have no confidence in the treatment of cholera by salol, by creolin, or by the use of Cantani's tannic acid intestinal flushing. They use and recommend subcutaneous saline injections.

APPENDIX E.

M. Giaard, chief of the Paris Municipal Laboratory, reports concerning the value of citric acid as a microbicide. He finds it to be a useful and efficient purifier of water, effectually destroying various morbid micro organisms in solutions of one grain of the acid to a quart of water.

APPENDIX F.

Sterilization of Water by Heat.

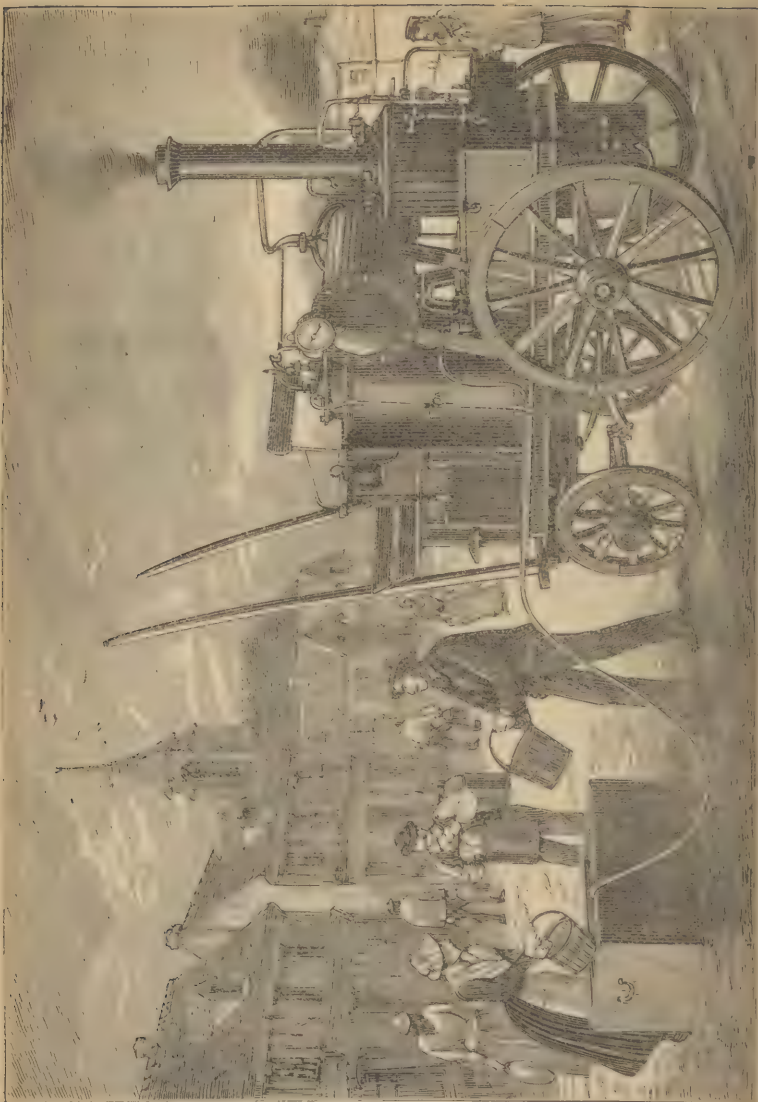
Hygienists have in all times recommended the use of boiled water when there was reason to suspect the water employed for drinking purposes. This precaution is still among those that the

attention of the public is earnestly called to, as soon as an epidemic of diarrhea, cholera, etc., is threatened or develops itself. But, although so general a measure is easy to indicate to private individuals, it is more difficult of application to the population in general of a crowded locality. This is the *raison d'être* of Messrs. Rouart, Geneste & Herscher's new apparatus for sterilizing water by heat. This ingenious apparatus furnishes the solution of a problem which has for many years occupied the attention of the Consulting Committee of Public Hygiene of France, and particularly of its eminent president, Prof. Brouardel. There is not a week passes in which the committee is not informed of the existence at some point in France of some epidemic or other, such as of typhoid fever, for which there is reason to recommend the use of boiled water to the population attacked. The same is the case in the army at every instant.

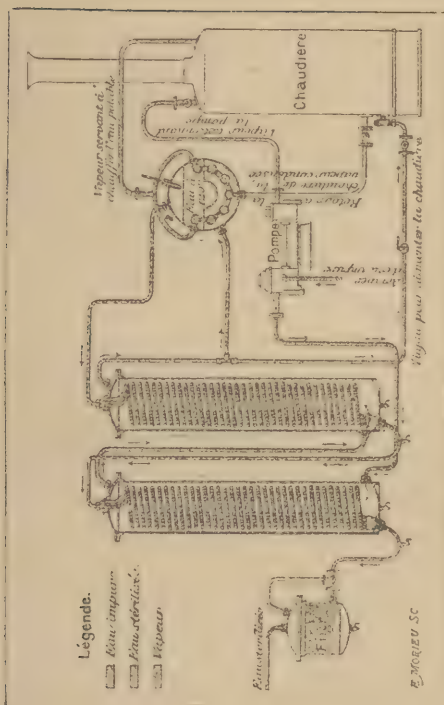
Now the French Board of Health, which possesses a most remarkable *material* of disinfection, has for a long time desired to add thereto some apparatus designed for the sterilization of water by heat, and which it might induce cities to procure, or which it might send to localities visited by an epidemic when the necessity therefor should be demonstrated. This project has just been put in execution after numerous tentatives, by Messrs. Rouart, Geneste & Herscher, in the following way: The drinking water is led into a pump, whence it is sent to the lower part of a metallic cylinder containing a worm. When this cylinder is filled, the water reaches the bottom of a second cylinder constructed in the same way, and then it is finally led to a receiver, in which it is heated to 120° C. under pressure, in contact with steam pipes connected with a boiler (Fig. 1). After the water has boiled for a certain length of time it is forced into the worms of the two cylinders designed for the reception, in the first, of the pure water: then after cooling, and a subsequent filtration through a layer of silicious sand, it flows outside.

The boiled water must be promptly consumed, for, like all pure water, it possesses the singular power of becoming rapidly, but temporarily, self infected. Whatever may have been said of it, it is easily digestible after it has been sufficiently aerated. It would be well, then, to obtain it in sufficient quantity, at least, for drinking purposes.

Fig. 2 gives a diagram of this ingenious apparatus, which comprises, essentially: A boiler with an independent steam reservoir,



APPENDIX F.—Fig. 1.—Apparatus for Sterilizing Water by Heat.



APPENDIX F.

Fig. 2.—Diagram of the Apparatus for Sterilizing Water by Heat.

one or more exchangers, and a filter. The exchangers, which are cylinders provided with worms, constitute the most interesting and original part. The impure cold water that they receive is heated by the temperature of the boiled water circulating in the return worms, and this same boiled water becomes cooled therein by giving up its heat to the water which goes to the boiler. In this way the exchange of temperature is effected without expense, and it is possible to easily furnish on its exit from the apparatus, water sufficiently cool to be used at once.

In fact, experience has proved that water that has been submitted in this apparatus for at least fifteen minutes, to a minimum temperature of 120° may make its exit therefrom with a temperature but 2° degrees higher than that which it had when it entered. As for the micro organisms that it contained, there no longer remain any trace of them. It is absolutely sterilized. The statements of Messrs. Miquel, Pouchet & Charrin are very precise and demonstrative on this point. It remains to be known how such an apparatus can be put in use. Messrs. Rouart, Geneste & Herscher have devised several arrangements to this effect. In one, it is by the aid of a hand pump that the water is introduced; in another, much larger, a pump fed by the boiler allows the impure water to circulate in the various parts.

These different models are mounted upon wheels, so that they can be moved about and installed *in situ* in communities visited by epidemics. Fig. 1 represents an installation of this kind upon a village square, whither the inhabitants are coming to fill their pails and pitchers with water that has been sterilized by boiling, that is exempt from germs, and that is without a disagreeable taste. They obtain the water from a tube, whose extremity they lift up, so as not to soil it.

The low net cost of water thus boiled favors the application of this industrial process, which has already rendered signal services in the barracks of the marine at Brest, where typhoid fever prevailed for many years almost in an epidemic state. *Scientific American*.

APPENDIX G.

The specific value of contaminated drinking water in spreading cholera is very noticeable and striking, in studying epidemics and outbreaks of the disease. Visitations in the City of London have been

remarkable on account of the differences in mortality tables in different parts of the city, similar in surroundings and general conditions, except as to supply of drinking water. In those districts drawing water from the river Thames, the deaths from the disease varied according to the amount of sewage, from 8 to 163 per 10,000 of population. During the epidemic of 1866 in London, the mortality in the district supplied from the river Lea was 63 to 111 per 10,000 of population, while in other sections the rate was only 2 to 12 per 10,000. The Broad Street epidemic in London has been very graphically described by the eminent sanitarian, Mr. Ernest Hart, in a recent address. In this case, the cholera was almost, if not entirely, circumscribed to the people using the water of a particular well, and the spread of the disease was checked on closing the well. A similar example can be found in the Königsberg epidemic in 1866, when the disease raged amongst those using water from the river Pregel, while but few cases occurred among those obtaining water from a distant source. Wherever cholera has existed, similar conditions are observed; cesspools containing cholera *dejecta* caused to overflow by sudden falls of rain, as a consequence wells in the vicinity becoming infected and cholera ravaging the families using the contaminated water. The history of the late epidemic at Hamburg is very interesting in this regard. Simultaneously in different parts of the city at the beginning of the epidemic, cases would occur and yet the lines of demarkation of the infected areas were well defined. Near Hamburg, and having the same general conditions of soil and climate, but with separate water sources are the cities of Altona and Waldeck. From the river Elbe, just above the harbor, Hamburg receives her water, which is delivered unfiltered throughout the city, and which is contaminated by sewage and refuse of all kinds on account of the tidal current reaching the source of supply. Higher up the stream in the same river, but above the contaminating influences of Hamburg's source, Altona draws her drinking water, which is treated by a system of sand filtration before distribution, while Waldeck is supplied from an inland sea. Attention is called to the fact that the two latter cities escaped the plague, while the former was severely scourged. Last year the pestilence stalked along the water courses—the Volga, the Don, the Dneiper and others—and in St. Petersburg nearly every case that occurred could be traced to the use of polluted water.

Very instructive facts are to be gleaned from the report of Dr. F. Clemon, taken from the *London Lancet* of May 16, 1893. He says: In the village of Ulybyshef (Vladimir Government) a laboring man arrived on the 29th of June from Kazan, where he had attended the funeral of his brother who had died from cholera. Three days later he sickened from the disease in the morning and died the same evening. The clothes he had worn remained in an out-building for a week. They were then washed in a stream from which the village drew its water supply. In a very short time cholera became epidemic throughout the village. In the Government of Viatka five villages situated along the banks of the same stream were invaded by cholera. The infection was traced to the systematic washing of linen belonging to the early cases, in the stream which provided the inhabitants of the five villages with their drinking water. No sooner was this practice forbidden than the epidemic began to abate. In the village of Upper Moulla (Perneskoj Government) the linen of cholera patients was washed in a pond. From the same pond the inhabitants drew their supply of drinking water, with the result that cholera raged throughout the village. As soon as the washing of linen in the pond was put a stop to, the number of cases of cholera began to diminish. In the *Indian Medical Gazette*, in the half-yearly report of sickness and mortality among the servants of the East India Railway Company, for the first half of the current year, an instructive instance of infection by cholera stools is reported. Dr. Bathe reports that there can be no doubt that the milk diluted with impure water was the cause of the outbreak of cholera among the European employees and their families stationed at Asanol. The milk supply was not equal to the demand, and the only water available for its dilution was procured by digging holes in the bed of a small river at a spot where the excreta of several cholera patients had only a day or two previously been thrown. Almost all those who suffered from cholera had partaken of this milk. At Jamalpur, a native child, suffering from cholera, was seen by Dr. Brooke lying on a bag full of rice, and the choleraic dejecta were soaking through the gunny bag into the rice. Had this rice been sent to some distant place where no cholera existed, and had cholera supervened on this rice being distributed and eaten, we might have been treated to various theories as to the origin of the epidemic; but it is very doubtful if the simple explana-

tion of the choleraic dejecta of the child would have been hit on. *Public Health* quoting the special correspondent of the *Times*, September 17, gives the following: In the town of Askhabad the cholera was already nearly extinguished when it suddenly blazed up again with extraordinary violence. On August 3rd there were only eleven patients left in the hospital and they were convalescent; a few soldiers also remained in the same state in the barracks. On that night twelve more soldiers were taken violently ill, and within a few hours a fresh outbreak appeared among the towns-people. On the following day four hundred were down with cholera. Energetic measures were taken, and the course of the disease was stayed, or stayed itself in three days, but during that time eight hundred persons took it, and about half of them died. It appeared that the soldiers who were first taken ill had gone down to a stream with their soiled linen and had washed it there, drinking also from the same water. The occurrence is very instructive from several points of view; but it certainly shows that the poison can be conveyed by clothes, and as such things can, apart from travelers, be absolutely excluded without any trouble whatever, it is wiser to exclude them. Dr. H. B. Millard reports facts of interest relative to the mortality from cholera in Paris last summer. The water supply of Paris has been for several years insufficient, and so costly that many arrondissements (or wards) have been obliged to drink the water of the Seine (boiled or not as they chose), which in 1892 was unusually low and dirty. It was in these arrondissements that the greatest mortality prevailed. In the three quarters, that of the Louvre, the Champs Elysées, and the 14th arrondissement (on the left bank of the Seine) which are the healthiest of Paris, there were not altogether more than nine or ten deaths. The next smallest mortality was in the 9th (Montmartre), which is on a height and very clean. The greatest was in La Villette (the 19th), the ragpickers' quarter. Every avenue must be guarded against in aiming to arrest cholera or prevent its entrance, and many curious and unlooked for sources of infection meet us when we study the subject closely. The *Lancet*, quoting the *Musical Times*, calls attention to the piano-forte as a focus of infection. A garment exposed to infection, says the writer, can be quickly disinfected, but it is far more difficult to fumigate all the multitudinous cloths, baizes, felts and woolen materials which the complex mechanism of a piano contains. It is questionable, indeed,

whether this is ever properly done. (It is questionable whether such a thing was ever thought of). Few pianos are regularly cleaned out. Dust accumulates in them and they become receptacles for all kinds of dangerous germs. Among musicians it is well known that one of the chief centres in Germany of cheap piano making is Hamburg; and especially in the slums of St. Pauli, where the cholera has been rife thousands of pianos are in course of construction, the majority of which are destined for the English market.

APPENDIX II.

The most popular place in New York, says the *Medical Record*, if the cholera comes, should be Shanty Town, and the proudest animal on this land will be the goat. For Dr. Klemperer, of Berlin, after going over the subject of securing immunity against cholera, and after trying all methods of protection, including the swallowing of a pint of cholera bouillon, finds that the milk of an immunized goat does the work best and most easily. Subcutaneous injection of the milk from the goat artificially made immune, was given to a man (who had volunteered). The injection of 5 c.c. of this milk produced such a degree of immunity that 0.25 c.c. of his blood serum protected a guinea pig against choleraic intoxication. There is hardly any doubt, says Klemperer, that goats may be made more resistant by further injection, and thus their milk will have greater anti-toxic properties. The author thinks it permissible to hope that 1 c.c. of such goat milk will protect men not only against the intoxication of cholera, but also against the infection. The price of goats has been five dollars and upward. When the cholera comes, this much ridiculed animal will take a position in history higher than the sacred bull of Egypt or the vaccinated calf of Jenner. Harlem, too, will become the centre of New York and not an uptown annex.

APPENDIX I.

Should cholera invade the country, attention must be paid to Railway Hygiene. An individual suffering from cholera and travelling on a railroad, by means of his dejecta could infect a large extent of territory. *The Annals of Hygiene*, quoting from *The Sanitary Inspector*, furnishes us with the Swiss regulations, promulgated

August 15, 1892, against the danger from cholera. These rules prescribe that the closets in railway carriages shall not discharge upon the ground, but shall be provided with a receiver securely attached to the lower end of the soil pipe, or by a removal of a portion of the pipe and the fixing of a vessel directly below the seat. Whatever form of catch basin is used, each must receive at least two quarts of milk of lime just before the train starts, and when the destination of the car is reached there shall be poured into each vessel a quantity of milk of lime equal to the quantity of its contents. After the vessels are emptied, they are to be abundantly rinsed outside and inside with the milk of lime.

APPENDIX J.

The Annals of Hygiene notes the character of butter as a bacillus medium. It is generally known that milk affords a dangerous vehicle for the dissemination of disease, but that this undesirable property is shared by butter is information at once of a novel and startling kind, and such as should put us on our guard. Yet, according to recent researches, there are contained in one gram of butter (as much as would go on the point of a knife) 2,465,555 micro-organisms from the centre of the pat, and as many as 47,250,000 on the outside. In fact, in some cases it is tolerably certain, it is stated, that the number of micro-organisms swallowed with a moderately large piece of bread and butter may excel that of the whole population of Europe. Butter kept in a refrigerator showed a marked reduction in the number of bacteria—a result which is also obtained by the addition of common salt. Samples of artificial butter, curiously enough, were invariably found to be much poorer in bacteria than ordinary butter; thus, while the smallest number found in one gram was 746,069, in real butter considerably over two million microbes was the minimum. Two varieties of bacilli have been isolated and described, and inasmuch as they were found to be constantly present in butter they were probably specific micro-organisms of a non-pathogenic character. But at any rate, it seems clear that butter as well as milk is capable of carrying and fostering organisms, and on this account it behooves us, under certain circumstances to melt our butter to boiling point in addition to boiling the milk.

APPENDIX K.

Quoting the *Pharmaceutische Zeitung*, *The Annals of Hygiene* describes the German savant as being eminently practical when it comes to beer, and as soon as the cholera assumed noteworthy proportions in Europe, he set about determining the duration of life of the bacillus in his—the savant's—pet beverage. He found that the bacillus does not live beyond three hours in Pilsener, Patzenhofer or Munich beer; two hours in Berlin white beer; five minutes in white and fifteen in red wine, and twenty minutes in cider. Two hours in cold coffee decoction (six per cent.) was too much for the bacillus; but it needed five hours of rye-and-chickory imitation to kill it. In milk which had been boiled for an hour the bacilli lived for nine days, but the tenth brought them to the end of their career. Cold tea was much the same, *i. e.*, a one per cent. brew, but a two per cent. tea cleared the field in four days, three per cent. in one day and four per cent. in an hour. The bacilli were most partial to cocoa; they did not appear to die off in that at all.

APPENDIX L.

From a most instructive, interesting and elegant monograph on the "Prevention of Cholera," by Prof. Daniel R. Brower, I make the following extracts, and hope in this way to extend more widely the valuable advice of this eminent author: "The principal vehicle for the spread of cholera infection is *water*. Germs that escape from the patient in the ways suggested, passing into the source of water supply, there thrive with great rapidity. It is our duty, therefore, to see to it that the water consumed by our patients is not only filtered, but boiled, and the boiling should be done recently. There is no filter, I have reason to suppose on the market, that is proof against the cholera germ. We should urge a thorough cleansing of the hands before eating, and should see to it that those domestics who are engaged in the preparation of our food, take the same precautions against the propagation of the disease. In the matter of diet, it should be simple, nourishing, ample and well cooked. Everything of doubtful propriety should be avoided, such as canned goods of all kinds, preserved meats, raw vegetables and fruits, pastry, cheese and nuts. Special attention should be paid to the milk. All the milk consumed should be boiled immediately before being

used. Particular attention should be paid to the cooking utensils. *We should impress upon our patients the very important fact that cholera germs that have been properly cooked are just as harmless as any other vegetable.* If a case of cholera occur among our patients it should be isolated. If the isolation can be made in their own home, there it should be done; but if it is not possible, by reason of circumstances, to secure this isolation, then they should be taken from their dwelling place to some hospital provided for the purpose. Then every effort should be made to avoid panic. Those who must be in attendance must be told that there is no danger of cholera attacking them unless the germs enter their bodies by their mouths; that cleanliness of hands and of person, and the proper destruction of germs by the processes already stated, will make this entrance impossible. We should give to our patients instructions as to what to do before the doctor arrives. On the first appearance of diarrhea they should go to bed at once; they should be kept warm; artificial heat applied to the extremities and to the abdomen. There should be administered as speedily as possible, either a moderate dose of castor oil in hot milk, or a moderate dose of calomel. They should be instructed to sip water slightly acidulated with sulphuric acid. If the looseness of the bowels continues, they should be instructed to inject at least a quart of hot water, containing about thirty grains of tannin and thirty drops of laudanum; and whatever is discharged from the patients by stool or vomit should at once be destroyed, either by heat or by some one of the disinfectants already enumerated."

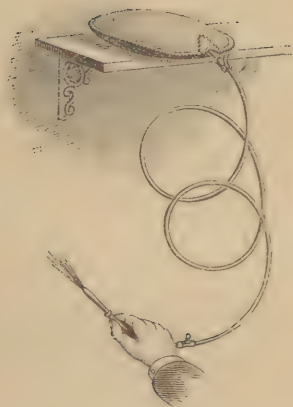
These instructions are full, complete and to the point, yet while I yield to no one as far as respect for the skill of Dr. Brower is concerned, I must take issue with him in regard to his recommendation as to enteroklysis. If the injection prescribed by Dr. Brower be intended by him to merely flush the large intestine, I subscribe to it unhesitatingly. But if the Doctor intends that any attempt be made to violate the integrity of the colic valve, I just as unhesitatingly pronounce against it. Such an attempt I believe would be dangerous, in the hands of the laity. I do not believe that Cantani's enteroklysis is a feasible operation, but any attempt made to flush the small intestine should never be made by any other than a physician.

APPENDIX M.

In considering the operation or procedure of Cantani enteroklysis—in the treatment of cholera, the following points present themselves:

1. Is the small intestine flushed by the fluid, or is the large intestine only involved; in other words, does the fluid pass the valve of Bauhin?
2. What are the main dangers to be feared in attempting to overcome the integrity of the valve?

In answer to the first question I would say, that depending on the observations of many eminent investigators, prominent among these being Senn and Oser, and on the results of experiments made by myself on the lower animals and on cadavers, there is no doubt in my mind whatever, but that in the very large majority of those on whom the method is used, the fluid washes out *only* the large intestine and does *not* reach the small intestine. The colic valve is intended to prevent material from passing out of the large intestine back into the small. The material that the ileum throws into the cecum is quite fluid or pulraceous, and a careful anatomical examination of the structures at this point will show that on account of the mechanism of the valve any attempt to produce regurgitation, but more tightly seals the opening. It is true in a few cases, by careful technique, in either the living or dead subject, fluid can be coaxed to trickle through the opening, but these instances are few, and in a given case it can not be prognosticated as to whether this result can be obtained. On the contrary, air or gas, introduced as described in the body of the text, will invariably pass the valve, producing incompetency by a lateral and longitudinal distension of the cecum, mechanically separating the valve margins. I have no doubt but that during life and in the healthy individual, a gaseous-hyper-distended colon can relieve itself in this manner. From personal observation I am satisfied that gaseous regurgitation occurs in cases of enteric fever accompanied by pronounced colic meteorism. In the cadaver, in cases in which the valve prevented the passage of fluid into the ileum when the intestinal tube was coiled up in its normal position, I have found fluid would pass, under the same pressure on attempting to straighten out the gut at the junction of the ileum and cecum.



Rubber Bag and Tube, with Rectal Tip, for performance of Entero-klysis. By replacing the rectal tip with an aspirator needle or tapping canula, the apparatus will serve for the performance of Hypodermoklysis.

With reference to the second question I would state that the danger *par excellence* that threatens us in endeavoring to flush the small intestine from below, is, injury to the bowel. As before seen, this injury may be a longitudinal laceration of the peritoneum on the convex surface of the bowel, or multiple ruptures from within outwards at the mesenteric attachment. But it must be borne in mind that under certain conditions, stretching the cecum may be a factor in producing ileo-cecal intussusception.

APPENDIX N.

Very interesting matters for consideration are connected with the entrance of the germ into the system and of its subsequent growth or destruction. We have already noted the antagonistic qualities of the normal gastric juice to the cholera spirillum: we have seen that should there be a deterioration of the stomach secretion, how ingested germs could safely pass the stomach and reach the intestine, where all conditions are favorable for growth and development. The reaction of the interior of the small intestine is *always* alkaline, there is no real need of any catarrhal process to produce such a condition; even when the acid contents of the stomach during digestion are poured into the duodenum, the alkaline bile, pancreatic juice and intestinal secretion rapidly and thoroughly neutralize and render decidedly alkaline the mixture. We have seen that water can enter the stomach and be emptied into the bowel without gastric functional activity being awakened, without any acid reaction being induced. In this case therefore, contaminated water could convey living cholera to the intestine. But even with a deteriorated state of the gastric juice, if infected *food* were taken, and the activity of the alimentary system called into play, even if living cholera unchallenged passed into the stomach and entered the gut, are there any conditions whereby the individual could escape the disease? Yes, there are; a prominent one being as follows:

It is a well understood fact, how the different portions of the economy are brought into relation with each other, and by means of the nervous system the various subdivisions associated in such a manner that stimulus applied to one organ may excite the activity of another. An excellent example of this is to be found in the digestive mechanism. Just as soon as we begin a meal, with the swallowing of the first bolus of food, the digestive system awakens

as it were from sleep. The musculature of the gall bladder contracts and bile is poured into the duodenum, the pancreas becomes rosy red and takes on functional activity, the stomach elaborates its juice, the glandular apparatus of the intestine increases its work, and peristaltic waves, quicker and more pronounced above, slower and less marked below, pass from above downwards. Sometimes these waves are continued rather forcibly over on to the large intestine. There are some people who have an urgent call to go to stool immediately after eating, and the desire begins to be appreciated before the individual leaves the table, before the meal is over. I am acquainted with a *bon vivant* who tells me he always wants to "defecate just before dessert." Now the substratum of the intestinal mucosa is adenoid tissue. We find a sustentacular framework of connective tissue with the interstices packed with leucocytes, which are accumulating in the intervals between meals. This tissue takes on activity as well as the other parts above mentioned. The leucocytes wander out of their prison cells and play an important part in nutrition. Employing their attributes as phagocytes, they seize on pabulum and at once dive deep into the tissues, entering lymphatics and blood-vessels and everywhere give up their precious freight. There is an enormous increase at this time in the body of these wandering cells, which gradually decrease in number until a little time after completion of digestion, when a condition of equilibrium is once more assumed. If, when these cells are swarming out of their nests into the cavity of the gut; if, when they are engaged in loading up with food solution, there should be cholera bacilli in this food solution, exemption from the disease might be produced by the destruction of the spirilla on the part of the phagocytes. If there were but a few morbid germs, the army of phagocytes would quickly overpower them, and the general economy would never know there had been any invasion. If, however, the invading troops were more numerous, the battle might be fierce and stormy, many on each side would be slain, the field of battle all torn up, but the phagocytes victorious. Then there might be a catarrhal enteritis of greater or lesser severity set up, and after the debris had all been expelled and removed from the bowel, the man would be again in full health and would refer his diarrhea, perhaps, to some indiscretion in diet. The subject is of the deepest interest, and I have not space here to continue further, but would simply

direct attention to protection from invasion from this point of view.

APPENDIX O.

In *Science*, Dr. A.S. Ashmead pleads for general asepsis, holding prevention to be better than cure. There is, says this author, a singular agreement of precept between some of our new philosophical schools and the doctrine of the Orientals as to our duty to the race in case of disease. The doctrine of our philosophers, teaching the survival of the fittest, and our duty to the race, not to interfere with the eliminating operations of nature, is not put into practice, and considering that Christianity is our religion, and is not looking forward at present to any imminent decline, it is not likely to pass into practice for some time to come. The Orientals criticize Christianity because it seems unduly and undutifully occupied in counteracting the decrees of nature, by saving, with fostering care, individuals of the race, preserving in hospitals all that ought to perish, and leaping up, so to speak, the sweepings of nature, to perpetuate moral and physical uncleanness. True, they also are anxious to build hospitals; but if they were let alone perhaps they might build them only for animals, whose races are not important enough to make it a pity that disease and vice should be allowed to be transmitted among them from generation to generation. Wherever the Oriental spirit has developed on its own lines, it has endeavored to eradicate the human weed, to sweep away all human influences detrimental to mankind, whether they be represented by disease or by crime, always ready to sacrifice any man to the interest of men. The leper was cast out to die with his disease in unpitied misery and solitude; the beggar, unable to earn his bread or support his family, was excluded from help and intercourse of any kind; what could the race expect from his seed? What is the use of amputating a limb which tuberculosis or syphilis or leprosy is gnawing at? Why should his seed be preserved to perpetuate his rottenness? Why should we so tenderly humor the madman, use infinite care and infinite treasures of knowledge, and miracles of skill, to bring the diseased brain into a condition which makes the man innocuous, tolerable, while yet he can never be normal, rational, useful; his brain fibre is degenerated and should not be transmitted to future generations.

When we Westerners discovered the bacterium we thought that here we had the cursed cause of all disease, and forthwith began to give her chase or to lay siege to her citadel. The Oriental may have thought dimly: Wherever you are, O, Microbe, you are in the state where Providence has placed you, and must do His behests. Yours is the empire of the abnormous, the morbid, the destructive. Whatever part of creation you establish yourself upon is by your very presence stamped as bad, unhealthy, undeserving of existence. Therefore stay in your domain, we do not envy it to you. Eat up, what belongs to you, it can do us only harm. These Eastern populations believe in fate; they are the true Stoics. What is written, is written, Kismet. If we are doomed to be cut off by cholera, we shall not escape it, and the fear of the inevitable shall not prevent us from plunging our limbs into the lethal waters of the Ganges, or quenching our thirst in the Mecca pools. And what does it mean, that our own people, not very long ago, considered the use of vaccine as being an interference with the will of Providence. They called Providence what in the Orient we call fate. It would seem that medicine in general is just the opposite of this magnificent supineness: the physician tries to save his individual, let what may become of the race; there is another kind of recklessness, not supine like the Oriental, but busy and officious. It would be a much higher task, if, instead of waging war against the bacillus, who has invaded an individual, medicine should find means to obviate and suppress the bacillus, or its development, or its culture, before it invades the race by the individual, that is, should create in the organism such conditions, should produce such constitutions, as would not allow of the existence of these microscopical pestilences. That would be *asepsis* instead of *antiseptis*. Here is what asepis has to do. It stands at the fountain head, its mission is to keep the spring of life free from impurity. Let a commission, or whatever body of scientific information and action, go to Russia, to the original habitat of the typhus germ, and oppose the development of its colonies before they begin their trip around the world. The first thing to do will probably be to improve the condition of the Russian Jew. Prevent the Hindoos from poisoning themselves with their holy water, with which they drink the blessing of cholera. Enact laws to isolate the syphilitic and the tuberculous. Prohibit the marriage

of such. Let the congenitally incurable die before puberty: it is better that the offending limb should be lost than that tuberculosis, syphilis, leprosy, etc., should spread through the whole body. Let the healthy, the temperate, the moral, alone have the inheritance. A correct life is the most perfect asepsis, and insures an immunity with which the burnt infant's immunity, known as such, cannot compare.

APPENDIX P.

Hare, in the *Therapeutic Gazette*, quoting Arthur Klein, reviews the present status of blood-serum therapy. According to these authorities, recent advances in this direction may affect the whole future of medicine. These show the blood in the light of a protecting organ for the rest of the organism. Much investigation remains to be made, especially as to the conditions of immunity from infectious diseases. Behring's blood-serum therapy is the most recent of these important discoveries, and has already found its way to the bedside.

By immunity we understand the power of an organ to defend itself successfully against the entrance of an infection. This immunity may be congenital or acquired. The congenital is peculiar to the animal genus, the acquired is the special acquisition of an individual; in both forms the immunity is specific, *i. e.*, for certain infectious diseases, but by no means for all. The rabbit appears to be non-inoculable by the bacillus *Friedlander*, the dog by the diplococcus pneumoniae, the rat by anthrax. If we see a horse survive a deadly dose of a tetanus culture, we know that he must have acquired the immunity artificially.

The methods of producing artificial immunity are numerous, but in general, they seek to follow the natural way as much as possible. There are two diverse views as to the manner in which the organism protects itself against disease. One view is that there are cellular portions of the blood—the leucocytes—which render the organism immune, by forming a wall against the causes of infection, taking them up and destroying them (as scavenger cells). One must imagine that the mobilizing of the white blood-corpuscles at the point of the outbreak of infection (local inflammation) is due to a chemical irritation, which proceeds from the infectious germs, attracting the white cells. Opposed to this theory are equally acute

observations, which see that the means of protection of the organisms consists in substances dissolved in the blood. (Neither of these theories alone will explain all the phenomena noticed in various instances. The recognition of both seems to be necessary.) The excitants of infection known to us may be divided into two categories. One kind is excessively increased in the body, growing through the tissues, pressing into the circulation, and threatening the organism by the very great hordes of parasites which are able to disturb or entirely stop the normal functions of the organs. These infections may be grouped under the general idea of septicemia (as anthrax, diplococcus infection).

Another portion of infectious germs increase but little in the infected animals, or at least remain confined to the infected place; the pathogenic micro-organisms which belong to these (as tetanus, diphtheria, cholera) do not enter the circulation, but they produce an intensely active poison, which is absorbed by the organism attacked, and thereby develops an activity injurious to the organism. This must be distinguished as an entirely different mode of infection from the former, and is designated as intoxication.

If it is possible to render animals immune against the toxins, there must exist anti-toxines.

If it is possible to produce a protective body of such power that it is able suddenly to render immune an organism where infection already exists, then the protective has become the healing substance, and the method of rendering immune, a healing method. For the congenital immunity, no general explanation of its origin is yet possessed. For that artificially produced, we are able to trace it confidently to a property of the cell-free blood. But in no disease against which a sufficiently high degree of immunity has been produced in an animal of originally light receptive powers, has any one been able to prove the absence of the bodies conferring immunity in the extravascular blood of the individuals rendered immune.

First, a high degree of immunity is to be produced in a receptive individual, and then trial is to be made to see whether the blood of the animal rendered immune produces a preventive and healing action upon others. Behring has tried to render rabbits immune from a tetanus infection. The culture, bred in meat broth, is reduced with carbolic acid to five per cent, which is now administered in five increasing doses, given by intraperitoneal injection. The

doses follow each other at intervals of from three to five days. If the injection is not well borne by the rabbit, instead of increasing the dose, the last dose given is repeated. The animal acquires a correspondingly increased degree of immunity, as examination of its blood-serum shows. It is also tested by ascertaining what quantity of the serum will render a white mouse of a given weight immune. After receiving the last of the five injections, the injections are of the culture in its full virulence, always increasing from very small to larger doses.

But for large and susceptible animals we must have either a blood-serum of enormous power to render immune, or use it in enormous quantities. This shows that larger animals must be chosen for the treatment, which can endure the loss of larger quantities of blood without injury to their health, and are able to supply the necessary quantities of blood-serum. Sheep are suitable, but above all horses, which Behring regards as the "travelling apothecaries of the future." The method used for rabbits needs only slight modifications to be applied to horses. Behring has already cured large animals with this, and Rotter reports one man successfully treated for tetanus; of course further experiment will develop a more potent cure.

Pawlowsky and Buchstab have made many experiments in this direction, after Pasteur's method.

A quantity of pure culture was injected into the blood of an animal and gave a negative result. By transmission of the peptotoxine through a series of rabbits and guinea-pigs a culture of great virulence was obtained. A dose of from three to five cubic centimetres killed the animals in from twelve to twenty hours. A very weak culture is injected into the blood or the peritoneal cavity and gradually increased up to the very powerful cultures. In the course of a month many animals were rendered immune. Five cubic centimetres of the virulent culture were injected into the peritoneal cavity, and in from one to five hours blood-serum from an immune animal was injected under the skin. Seventy-five per cent. of the animals lived. All the control animals died. The authors claim to have isolated a substance from the blood-serum of immune animals which possesses as much power to render animals immune as the blood-serum. They experimented upon

themselves with the serum from immune animals but no changes were noted.

APPENDIX Q.

A fact of great value that we have to notice is the advanced position taken by many theologians in these later times. Dr. Briggs' courage and his manly stand in defense of his conscience have now become matters of history. It is lucky for the Doctor that he lives in the nineteenth century. In earlier times the officers of the Holy Inquisition would have paid special attention to his soul's welfare (at the expense of his physical integrity), or he might have shared the fate of the monk Servetus, who at Calvin's instigation, was burned at Geneva in 1553. A remark of the Right Reverend Dr. Potter, Protestant Episcopal Bishop of New York, may be cited as an example of this newer and broader theological thought. When, last summer, this distinguished, enlightened and learned prelate was memorialized by members of his flock to issue a circular letter to all the churches in his diocese calling for general supplication to the Most High to avert the plague from the Empire City, he consented, but advised his petitioners to gird up their loins and cleanse the city.

APPENDIX R.

The *Practitioner* quotes Pettenkofer at length concerning cholera etiology. This authority believes that cholera is impossible without the simultaneous action of three etiological factors:—*X*, the specific germ of cholera disseminated by man; *Y*, the peculiar and subtle influence of place and season; and *Z*, the personal equation as represented by the individual predisposition. These three factors, he thinks are equally potent and equally necessary. To the majority of those who have studied cholera epidemics, the factor *Y*, or the influence of place and season, is a negligible quantity, and quite subsidiary to the *X*, or specific germ which, unless the organism be in a state of absolute immunity, once having gained access to the body is alone sufficient to give rise to cholera. On the other hand, von Pettenkofer attaches the greatest value of importance to the *Y*; to him the *X* and *Z* are not enough, and unless supported by the presence or existence of his factor *Y*, are unimportant.

On October 7th, 1892, von Pettenkofer swallowed one cubic

centimetre of a fresh bouillon cholera culture; and moreover, to guard against any possible antagonistic or protective influence of the acid gastric juice, he neutralized it by taking at the same time one gramme of bicarbonate of sodium dissolved in 100 cubic centimetres of Munich water. In order to give the experiment every chance, von Pettenkofer in no way altered his manner of living, or his habits. At noon the same day he consumed soup, eggs, black bread, a salad, some rice-cake, prunes, and coffee with milk. Similarly in the evening he partook of meat, potatoes, cheese, bread and butter, as well as a litre of beer and some alkaline water.

On October 9th, or some forty-eight hours after taking the cholera-broth culture, the first symptoms of intestinal irritation appeared. These consisted of borborygmi and some six to eight liquid motions, the appetite, power of working and sleeping, remaining, however, good. His condition remained the same during the next three days, the only marked discomfort being some flatulence and looseness of the bowels. So far no remedial measures were adopted; but on the 13th a warm cordial of wine was taken. The diarrhea gradually abated and entirely ceased on the 15th.

All the excreta were carefully submitted to a microbiological examination by competent experts, with the result that comma-bacilli were found in large numbers—some of the motions consisting almost of pure cultures, but no commas were noted after the 16th. Von Pettenkofer's own words regarding his experiment upon himself are worth recording at this point. He said: "Nearly all bacteriologists are agreed that the comma bacilli cause Asiatic cholera, not by penetrating into the general organism through the intestinal walls, but by remaining in the bowel, and there elaborating certain products which on absorption give rise to the infection.

What a quantity of poisonous products must have accumulated during those eight days in my intestines from those millions of comma bacilli! And yet I enjoyed good health, I had a good appetite, I experienced no symptoms of auto-intoxication, I had neither sickness, albuminuria, nor collapse; I was able each day to fulfil my duties. I concluded that the comma bacilli certainly give rise to diarrhea, but they do not cause either European or Asiatic cholera. Had my experiment been performed in Hamburg

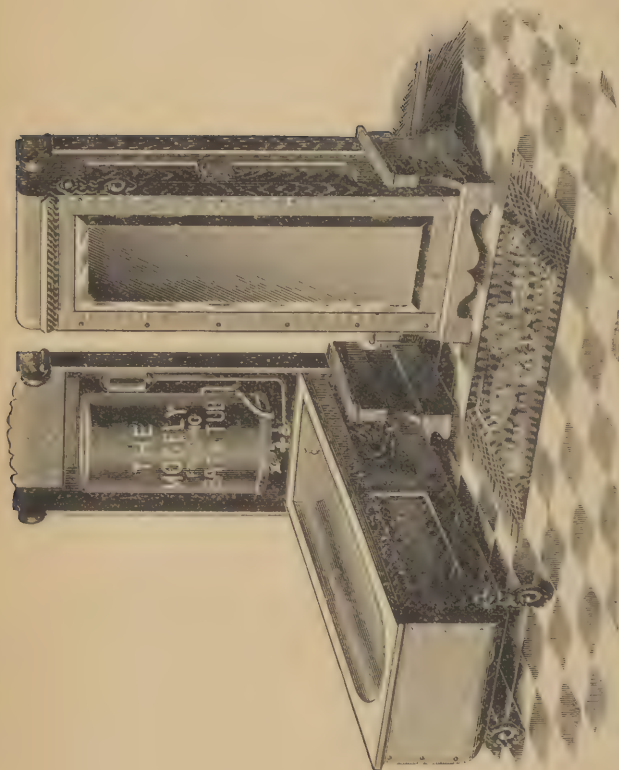
it might have been, and probably would have been fatal, because on that day, October 7th, there existed in Hamburg *V* in sufficient quantity to cause cholera, even with a minute quantity of said *X*." (It seems to me as if Prof. von Pettenkofer's reasoning were not perfectly logical. In the first place the germs swallowed by him had been sent to him from Hamburg, and were cultivated in bouillon, before being swallowed by him. This virus might therefore be looked upon as having been attenuated. Again it seems to me as if the learned Doctor places too much stress on his *V*, to the neglect of his *Z*; *V* he describes as the peculiar and subtle influence of place and season, while by *Z* he indicates the personal equation as represented by the individual predisposition. It appears to me as if *Z* were just as valuable as *V*, and were I a believer in von Petten-

kofer's theory, I would describe cholera as *X* + *Z*. Not *every* one swallowing the specific exciting cause of cholera, will suffer from the disease; not *every* one taking into his digestive tract the bacillus typhosus, will have enteric fever; not even will *every* unprotected person exposed to variola contagion, contract small-pox. In order that one should contract one of these diseases, the exciting factor must be present, and contributory conditions must be favorable. Now of these predisposing causes the most important is the personal equation before mentioned. In Pettenkofer's case, his powers of resistance were normal, his vitality was at par, the Metchnikoffian attributes of his mesodermic cellular elements were active, and he escaped.

Still cholera microbiology is not yet absolutely understood and the reader is again referred to Prof. Nencki's observations on mixed infection (Lecture II.)

APPENDIX S.

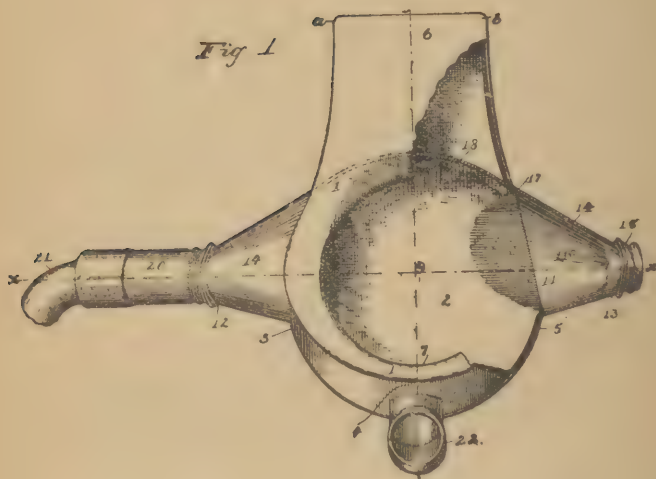
At the fifth meeting of 1893 of the Calcutta Medical Society, held in the medical college hospital theatre on Wednesday, May the 10th, the chairman, Dr. C. K. Bose, read a paper on "Some Points Connected with Cholera." He first dealt with the obscure history of cholera, referred to allusions made by the Chinese and Mahomedans in their sacred writings, to the writings of Casperez,



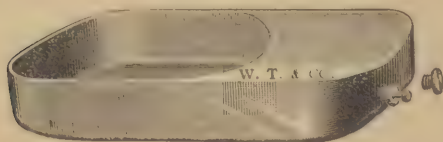
A folding, portable Bathing Apparatus, of especial use in the administration of hot baths in cholera. There being a hot water heater attached to the bath it is shown in cut, the water can be raised to any temperature and kept uniform for any period of time. Being on castors this bath has the advantage that it can be brought close to the patient's bed, thus obviating the bad effects of extra movement or disturbance.



The Knowlton Portable Bath, consisting of a frame from which is suspended a strong bag. The ends of the frame are to be supported on two chairs brought near to the bed, and the patient may then be bathed with the minimum amount of disturbance and annoyance.



Dugot's Combined Bed Pan. This contrivance is far in advance of any similar invention.



Bed Pan for use in bowel flushing. At one end is seen an exhaust tip to which a rubber tube may be attached, and the returned fluid carried off to a pail, or other suitable receptacle on the floor.

Sydenham and MacNamara. Cholera, he said, had selected Calcutta as a centre of infection and from there it was transferred to different parts of the world. The reason why it was so, was interesting. The soil of Calcutta was soft, the summer was a prolonged one, and the winter comparatively short, the rainy weather extending from June 15th to the end of August, the average rain fall being 66 inches. The highest temperature 100°, and the lowest 60° F. The climate was hot and moist, and therefore favorable to the growth of the micro-organism. The northern portion of the city was occupied mostly by natives, the houses and locality being in a very insanitary condition, while the southern part which was healthy and well looked after, was occupied by Europeans. Of the population of Calcutta, only twenty-nine per cent. belonged to the place, this number being born there, the rest coming to it from other parts. In the northern part of the town, the building arrangements were very bad, the very poor lived in bustees, each bustee having a tank in the centre. The water from these tanks is used for cleansing cooking utensils, purposes of ablution, and what is most revolting, this same water is used for drinking purposes, owing to the occupants of the bustees being too lazy to get water from the taps near by. From these bustees the infection begins in many outbreaks of zymotic diseases. The sources of access into the town are very often very difficult to trace; the sources of conveyance are twofold, those within the town, and those from without. Those within are mainly sanitary defects. In the native portion of the town, the streets are very much neglected, for instance in Burra Bazar, the streets are not even cleaned once a week. Cholera and typhoid may arise from the underground system, and the system as it is, can not be properly carried out in the native part of the town without danger to the health of the people. While much improvement has been done, still until direct information is lodged with the health officer, very little care is bestowed on the native portion of the town; debris and other refuse lie about the lanes for many days, and very often in a state of putrefaction. In case of death from cholera, small-pox, etc., the bedding, pieces of rags, etc., are thrown into the streets, blown around by the winds and very often stick near a water-pipe, till the *domes* come to collect old rags, etc., for the purpose of sending to England, to the paper factories, and thus the disease is carried with all

its mischievous results. Another source of mischief to be found in some of the native houses is that the tap with filtered water is near the latrine, and a drive to the neighborhood I have referred to, would convince the most sceptical. The *blistees* and *goalahas* with their adulterated supplies, are sources of mischief from without the town, and if the germ theory of infection be correct with reference to cholera, then milk is the best medium for the bacilli. Of course many use boiled milk, and others use raw milk. . . . It is known that ignorant confectioners who come into town bring cholera with their milk.

So far the factors of infection and spread of cholera have been noticed, and in passing I may mention, that good filtered water is of more value than one hundred therapeutical agents, *which article is in many instances denied by the Corporation.* As an instance of their procedures, I will mention one case of cholera which happened the other day at Manicktollah, and the *cause was traced to the consumption of foul water, the municipality having disconnected the filtered supply owing to the municipal water rate not having been paid.* The medical attendant made an application to have the connection restored, but it *could not be done without payment of the rates.*

While cholera may appear at any season, the summer seems to be the most favorable time. In March, April and May, the mortality is high. During the *holi* festival the natives take in all kinds of food and drinks, they use opium, bhang and sweetmeats, and these with debauchery and irregular meals. They cover their bodies with red paint, and at this time cholera generally breaks out and dozens die. In Orissa during the *rath jathra* festival, many deaths occur, also at the *kumbh mela* and the *ardohya jog*, while the disease abates after the festival is over. In different sections of the town, when there is a case of cholera, the discharges, soiled rags, etc., are very often thrown into the streets, or if the stools happen to fall upon the floor of the house, they are covered with ashes, and then removed to be thrown outside of the door of the house. In houses of the poor, or in places where gunnies are piled for sale, if a case of cholera occur pieces of gunny are used to wipe up the stools and vomit of the patient, which are afterwards sent to the *dhoby*, and then used for making gunny bags. With regard to the contagiousness of cholera, a case was

mentioned where a native mother had been nursing her child who was suffering from cholera, and although contact could be no more pronounced than in this case, as the child was in her arms all through, and her hands were simply soaking with the cholera stools, etc., yet she escaped.

A peculiar circumstance was reported where a party of twenty-two men went to *Kalighat* and stayed near a filthy tank: they all ate and drank equally, and after performing their rites they returned home. Nine of these men were attacked with cholera and died, the other thirteen were opium eaters and were *not* attacked. Dr. Bose then concluded by referring to immunity from cholera after one attack in connection with recovered cases of cholera in native houses.

APPENDIX T.

J. G. Santchenkoo, in the *Wratch. Annales. de l'Institut Pasteur* discusses the part played by flies in the propagation of cholera epidemics. The recognition of this fact is not new. In 1884, in a report to the French Government, *Dr. Paul Gibier* called attention to the dangers which flies cause, by saying that these insects, which are so numerous in summer, impregnate their bodies with germs caught in contaminated places and transport them into our houses and victuals. But Santchenkoo has sought to study the minute mechanism of the transportation of germs. He has fed flies with a liquid culture of choleraic bacilli. Then he has searched for the microbe in the excrements of the insects. At the end of two hours he had already obtained colonies of comma-bacilli among other and different bacteria. Twenty-four hours later the number of choleraic bacilli was much more considerable. From these observations the investigator concludes that the part of flies is not limited to the expansion of microbes which they may have swallowed, but that the bacilli are easily propagated in the **intestinal canal of this insect.**

Klebs has been studying the therapeutics of a re-agent which he calls "Anticholerine." He prepares it by concentrating large quantities of sterilized cholera cultures over a water bath, and removing the toxic substances by means of absolute alcohol. The residue possesses bactericidal and immunizing powers. By adding a few drops of a concentrated solution of anticholerine to agar, we

produce a culture medium which is antagonistic to the development of the comma-bacillus, and if to a rapidly growing culture, a few drops of anticholerine be added, the development ceases and the culture dies, while streptococci grow freely in the medium.

The non-toxicity of anticholerine was demonstrated by injecting guinea-pigs and especially those in a tubercular condition, which are peculiarly susceptible to cholera. Klebs and Schneider have injected themselves with quantities corresponding to eight cubic centimeters of filtered culture without any evil effects. Two guinea-pigs were inoculated intraperitoneally with 0.5 cc. of pure culture of comma-bacilli. One, which had received an injection of anticholerine, remained in perfect health. The other which was not protected, had a rise of 9° F. in temperature and lost much weight, but it finally recovered.

Of two other guinea-pigs, the control animal died of cholera, while the one that had been treated with anticholerine two hours after the injection of the pure culture, remained in good health for six days, when it died of a prolapse of the intestine through the operation wound.

Notwithstanding the small number of experiments he had made, Prof. Klebs did not hesitate to use his remedy in Hamburg. The patients were inmates of barrack F, where the severest cases were admitted, among whom the mean death rate was 80 per cent. The result was that the mortality fell from 80 per cent to 63 per cent, and Dr. Manchot of the Eppendorf Hospital considered that the anticholerine prevented the febrile reaction. Among many similar cases, was that of a young man who was stricken with cholera at an early hour and was admitted to the hospital at 11 a. m. On the first day, five, and on the second day, six cubic centimetres of anticholerine were injected. The temperature, which was only 35° C. (95° F.) on admission, rose the same day to 36.7° C., and the next day oscillated between 37.2° and 38° C. (90°-100.4° F.)

APPENDIX U.

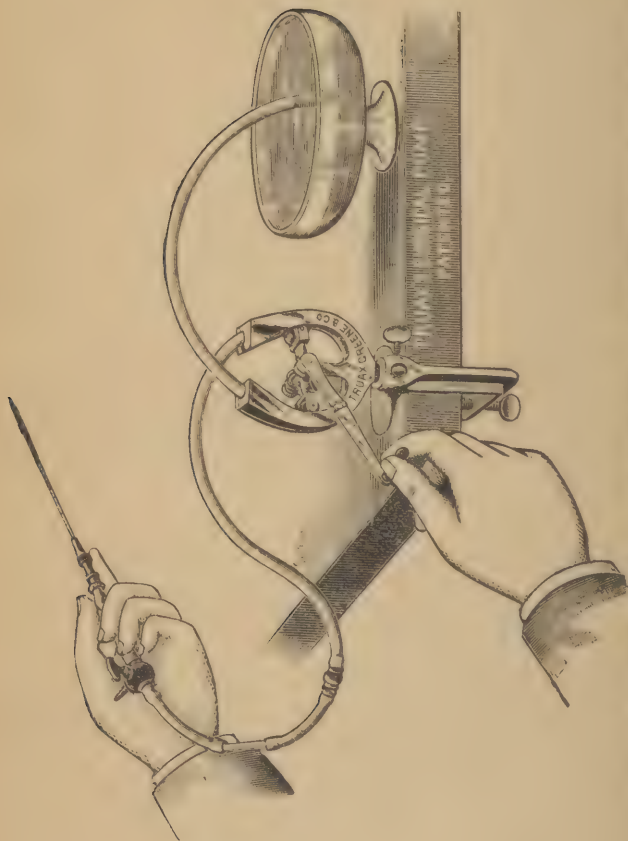
Carried away by zeal and a desire to benefit mankind the worker in practical preventive medicine may be tempted to depend too much on analogy or unsupported theory in forming deductions, if he neglect consideration of known physiological data. The questions of immunization against cholera, of hypodermo-

clysis, and intra-vascular transfusion are all of potent and engrossing interest, and the special physiological fact to which I would call the attention of observers in this field, is as follows—heterogeneous blood plasma or serum should *never* be used, in other words the blood (or serum) of the lower animals ought never to be transfused into the *blood vessels* of man. As a general rule the blood serum of one mammal will dissolve the blood corpuscles of another mammal.

When foreign or heterogeneous blood is transfused, two dangerous and serious phenomena occur: 1st. The corpuscles undergo solution. Before they are dissolved they run together and form sticky masses, consisting of ten to twelve corpuscles, which are apt to occlude capillaries and even arterioles. After a time the zoöid is separated from the oekoid or stroma, which yields a sticky, fibrin-like mass that may occlude fine vessels. 2nd. As a result of the solution of the discoid corpuscles, hemoglobin is set free, which reddening the plasma and appearing in the urine constitutes hemoglobinuria. The presence of a large amount of dissolved hemoglobin causes extensive coagulations within the blood vessels, usually in the venous system and in the large vessels, and death may ensue immediately, or after a longer or shorter period of time. Dissolved hemoglobin seems to increase in a most marked manner the activity of the fibrin ferment. There is no necessity of my touching upon the clinical picture involved, which for obvious reasons is complex.

Other fluids have been transfused, normal saline solution (0.6 per cent. NaCl) aids the circulation in a purely mechanical way, and even excites the circulation. In severe spanæmia this fluid can not maintain life. The injection of fluids containing peptone, even in moderate amount, is dangerous, as paralysis of the vessels results. The injection of milk is fraught with either immediate or ultimate danger; fever follows the operation, and the milk globules cause the occlusion of many vessels, producing subsequent degenerations. Fat may appear in the urine and there may be fatty infiltration of the uriniferous tubules. The urine contains sugar and albumin, the liver cells often contain fatty granules, and the weight of the body diminishes. If too large a quantity of milk be transfused, death occurs, and when unboiled milk is injected, numerous bacteria are developed in the blood.

These facts (as to heterogeneous serum) must be borne in



The Truax Apparatus as used for hypodermokinesis. By removing the needle and attaching a canula it may be used for intra-venous or intra-arterial transfusion.

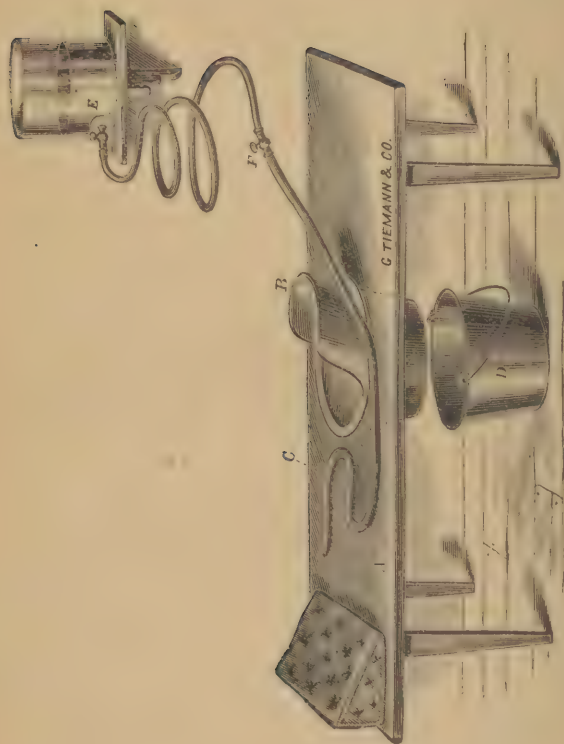
mind in connection with the hypodermic injection into man of pre-immunized goat's or horse's serum. Should this method be used the minimum amount of the serum must be determined that will produce the looked-for therapeutic result without disturbing to a too serious an extent, the physiological integrity of the blood.

APPENDIX V.

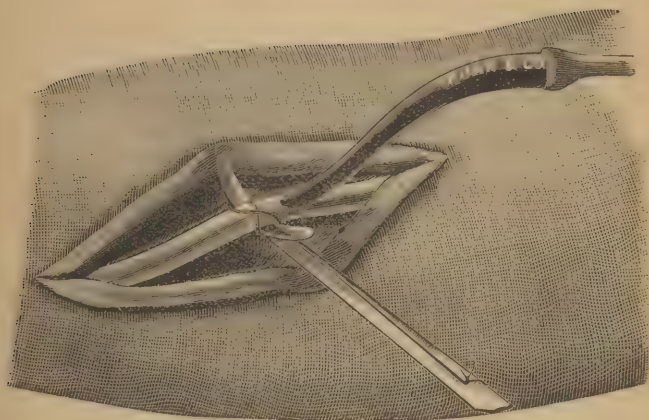
The "Elmer Lee" table for the performance of enteroklysis, designed by Dr. Elmer Lee of Chicago, and intended principally for hospital service. Dr. Lee sums up the minutiae of detail as regards the technique of bowel flushing as follows: "Irrigation of the bowels is to be accomplished with warm water, made soapy with some neutral liquid soap, or a good Castile soap, using from 1 to 3 gallons (say 4 to 12 litres) at a time, twice a day for the first and second days, and once a day afterwards if required. The operation is performed with a soft rubber tube one metre (39 inches) in length, and of suitable size to be introduced into the rectum, in front of the promontory of the sacrum, into and up through the sigmoid flexure, and into the descending colon. This tube which is connected with a reservoir, should not be too small nor too large, in order to facilitate its introduction through the folds of the sigmoid portion of the lower bowel. In fact the greatest difficulty to be encountered, is to successfully pass the tube in front of the promontory of the sacrum, and enter it into the sigmoid flexure. The tube should be of proper firmness to prevent it from bending or buckling upon itself when the end (which in all cases should be rounded) comes into contact with the obstructing folds of the intestine."

APPENDIX W.

The late Prof. Peter, of Paris, insisted that cholera nostras or cholerine and Indian cholera are for all practical purposes one and the same malady. He believed that cholera nostras is contagious like cholera, and that under favorable conditions it may become epidemic. He reported a rapidly fatal case occurring in France where no other cases existed, in which the symptoms were the same as in Indian cholera, and in which the autopsy showed the same changes as are found in true cholera. Many examples are recorded by Prof. Peter showing how what at first seems simple cholerine



APPENDIX V. The "Elmer Lee" Table for the performance of Enteroklysis.



Canula in situ in intra-venous transfusion.

may rapidly become an epidemic of true cholera: and it is therefore on every ground desirable that cholera nostras should be looked upon as true cholera, and the same precautions taken to prevent further cases as have been found effective in preventing the spread of the more severe disease.

APPENDIX X.

An official report of the Governor-General of Turkestan, which has recently been published in St. Petersburg, according to the *British Medical Journal*, states that the province has been severely visited by an epidemic of the "black death" which followed on the footsteps of cholera. It appeared suddenly at Askabad, and in six days killed 1303 persons in a population of 30,000. "Black death" has been long known in Western Asia as a scourge more deadly than cholera or the plague. It comes suddenly, sweeping over a whole district like a pestilential simoon, striking down animals as well as men, and vanishes as suddenly as it came, before there is time to ascertain its nature or its mode of diffusion. The visit here referred to was no exception to this rule. After raging in Askabad for six days, the epidemic ceased, leaving no trace of its presence save the corpses of its victims. These putrefied so rapidly that no proper post-mortem examination could be made. The Governor-General gives some details as to the symptoms and course of the disease, which though interesting as far as they go, do not throw much light on its pathology. The attack begins with rigors of intense severity, the patient shivering literally from head to foot; the rigors occur every five minutes for about an hour. Next an unendurable feeling of heat is complained of; the arteries become tense and the pulse more and more rapid, while the temperature steadily rises. Unfortunately no thermometric readings or other precise data are given. Neither diarrhea nor vomiting has been observed. Convulsions alternate with syncopal attacks, and the patients suffer intense pain. Suddenly the extremities become stiff and cold, and in from ten to twenty minutes the patient sinks into a comatose state, which speedily ends in death. Immediately after he has ceased to breathe large black bullæ form on the body, and quickly spread over its surface. Decomposition takes place in a few minutes.

APPENDIX Y.

Dr. James F. Hibberd, in an address on cholera, remarks: The comma bacillus is a small microbe about the 1-25000th of an inch in length and one-third of that in transverse diameter. We can hardly conceive of a living thing so minute. It would require 1000 of them placed end to end, to extend 1—25 of an inch, and a sphere of the size of an ordinary drop of fluid would contain 523,600,000 of them. . . . It breeds by each spirillum dividing itself into two spirilla and each of these into two more, and so on. This division has been seen to take place in the laboratory in twenty minutes after a spirillum had been planted, or placed in a suitable culture medium; but let us suppose such division to be complete once an hour, a simple calculation will demonstrate that at the end of twenty-four hours the descendants of this one microbe would number 16,777,216. As it must be a rare thing for a person who swallows such a microbe to swallow only one, when a drop of fluid may contain millions, we can readily understand why, when a person becomes affected with cholera, he is so quickly, so severely, and so dangerously diseased.

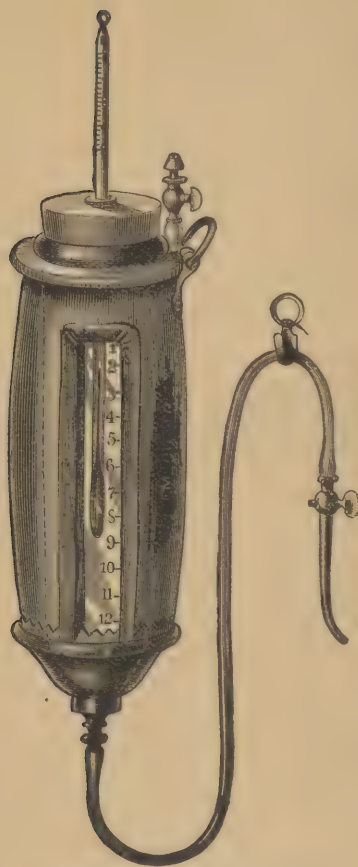
APPENDIX Z

Dr. Wm. Henry Porter, in the *American Medico-Surgical Bulletin* reports concerning Uffelman and Neisser's observations as to whether living cholera bacilli can be brought into the air by dust or garbage.

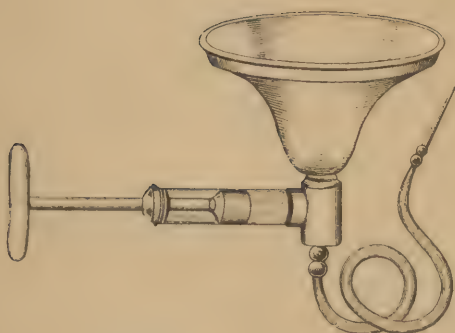
It is generally accepted that cholera bacilli can not be transferred by air. This statement is based on the belief that the vitality of the bacilli is soon destroyed by desiccation and that they can only be brought into the air when in a dry condition.

The latest experiments have shown that the vitality of the bacilli is not so readily destroyed by desiccation as it is generally thought. If this is the case, the important question comes up: whether the air can not be infected with living cholera bacilli by dust charged with them. To come as near as possible to the truth, Uffelman has carefully conducted some experiments to ascertain how long cholera bacilli retain their vitality in dried ground or dust, and whether they are brought into contact with air while living.

Neisser has experimented to some extent in this field. He satu-



Hutchinson's Transfusion Instrument.



Reservoir with pump attachment to insure the passage of the fluid.
Used in Germany. (BARTHOLOW.)

rated a piece of linen with cholera bacilli, and after drying it he passed over it a current of air which was brought into contact with a nourishing medium. He failed in producing any results. Had he however reduced the linen to powder, his observations might have shown different results.

Uffelman's experiments with garden ground-dust and garbage were conducted in the following manner: After previous sterilization he took a small portion of the dried substance, and saturated it with water charged with cholera bacilli, under exclusion of sunlight and at a temperature of 15° C. (59° F.) He kept it until perfectly dry again. It took from sixteen to twenty hours to dry. Then he took a small portion of the dried substances, reduced them to a powder, and made some cultures on gelatine medium. Numerous experiments showed the following results: At sixteen and one-half hours, or just after complete dryness, thirty to forty cholera colonies were found; after twenty-four hours, three colonies; after forty-eight hours, one colony; and after seventy-two and ninety-six hours, no cholera colonies were found. In another experiment, Uffelman blew a small portion of the pulverized infected material, eight hours after it was dried, on a gelatine plate. He found six cholera colonies; after forty-eight hours no bacilli were developed.

From these experiments, Uffelman comes to the conclusion that most of the cholera bacilli lose their vitality in dried ground-dust or garbage within twenty-four hours, but in some cases they retain their vital activity for a much longer time, and in exceptional cases, for three days. These experiments tend to prove that these bacilli can become intermingled with the air before they have lost their vitality.

